

Division of Environmental Response and Remediation COMMENTS ON THE OPERABLE UNIT 9

RECORD OF DECISION

HILL AIR FORCE BASE, UTAH

SPECIFIC COMMENTS:

1. Section 1.7, Page 1-5: Please revise the signature block for UDEQ as follows:
Alan Matheson
Executive Director
Utah Department of Environmental Quality
1. Section 1.2, Page 1-1: The Statement of Basis and Purpose in the Declaration should use the same language agreed upon for State concurrence as in the ROD for OU11: "The USAF and EPA jointly select the remedy at Hill AFB. The State of Utah concurs with the selected remedy."
2. Sections 2.8.1 and 2.8.1.2, Page 2-20: The performance of Five-Year Reviews at this site is a statutory requirement because hazardous substances will remain above levels that allow for unlimited use and unrestricted exposure. However, the requirement is adequately addressed in the statutory determinations sections of the ROD (Sections 1.5 and 2.12.6) and it need not be cited as a remedy component in Sections 2.8.1 and 2.8.1.2. We recommend that references to it in these sections be deleted.
3. Table 2-19: Please include UAC R317-8-8 (Pretreatment) as an ARAR in the document if the remedy involves any discharge to a POTW of purge water from existing wells or development of new wells. If purge water will not be discharged to a POTW, please clarify how it will be managed and what requirements will be met for disposal.
4. Table 2-19: The table cites UAC R655-4-12 and R655-4-13 as applicable action specific ARARs. Based on information provided in the "Requirement/Purpose" and "Applicability" columns for Water Rights, R655-4-14 (Abandonment of Wells) and R655-4-15 (Monitor Well Construction Standards) should also be cited as applicable action-specific requirements.
5. Table 2-19: The State of Utah Air Quality rules in the table should include UAC R307-309-5 (General Requirements for Fugitive Dust) as an applicable action-specific requirement in addition to R307-309-6.
6. Table 2-19: The Environmental Response and Remediation rules cited in the table should include UAC R311-211-4 (Prevention of Further Degradation) as an applicable action-specific standard in addition to R311-211-2.
7. Table 2-19: The Solid and Hazardous Waste rules in the table should include UAC R315-1 (Utah Hazardous Waste Definitions and References) as applicable action-specific /chemical specific standards in addition to R315-2.
8. Table 2-19: While it is appropriate for the table to discuss the Accumulation Time provisions of the Hazardous Waste Generator Requirements (UAC R315-5-3.34), other substantive provisions



State of Utah

GARY R. HERBERT
Governor

SPENCER J. COX
Lieutenant Governor

Department of
Environmental Quality

Alan Matheson
Executive Director

DIVISION OF ENVIRONMENTAL
RESPONSE AND REMEDIATION

Brent H. Everett
Director

New s/e
ref 1574521

ERRC-097-15

July 21, 2015

Mr. Jarrod Case, P.E.
AFCEC/CZOM Hill Station
7290 Weiner Street, Building 383
Hill AFB, Utah 84056-5003

Dear Mr. Case:

The Division of Environmental Response and Remediation has reviewed the Records of Decision for Operable Units 9 and 10. Enclosed are our comments. Please feel free to contact me at (801) 635-4178 if you have any questions.

Sincerely,

Muhammad A. Slam, Project Manager
Division of Environmental Response and Remediation

MAS/pd

Enclosure

cc: Sandra A. Bourgeois, U.S. Environmental Protection Agency, Region VIII



Hill Air Force Base, Utah

Final

Operable Unit 9
Record of Decision

SEPTEMBER 2015

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE (DD-MM-YYYY) 15-09-2015		2. REPORT TYPE Final		3. DATES COVERED (From - To) 6 SEP 2013 – 8 AUG 2015	
4. TITLE AND SUBTITLE Operable Unit 9 Record of Decision Hill Air Force Base, Utah				5a. CONTRACT NUMBER FA8903-09-D-8560	
				5b. GRANT NUMBER None	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) EA Engineering, Science, and Technology, Inc., PBC				5d. PROJECT NUMBER	
				5e. TASK NUMBER 0006	
				5f. WORK UNIT NUMBER None	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) EA Engineering, Science, and Technology, Inc., PBC 2363 N. Hill Field Road, Suite 104 Layton, Utah 84041				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Air Force Civil Engineer Center 2261 Hughes Avenue, Suite 163 JBASA Lackland Air Force Base, Texas 78236-9853				10. SPONSOR/MONITOR'S ACRONYM(S) AFCEC	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT					
13. SUPPLEMENTARY NOTES None					
14. ABSTRACT This Draft Final Record of Decision (ROD) presents the final remedial actions for Operable Unit (OU) 9 at Hill Air Force Base, Utah. This document was prepared under Contract No. FA8903-09-D-8560, Task Order 0006. The contaminants of concern (COCs) associated with the Installation Restoration Program (IRP) sites addressed in this ROD include carbon tetrachloride (CT) in groundwater at Site SS108 (800/900 Area), trichloroethene (TCE) in groundwater at Site SS089 (1100 Area), and TCE and tetrachloroethene (PCE) in groundwater and soil at Site SS090 (Golf Course Area). In addition to the three IRP sites addressed in this ROD, OU 9 consists of five other sites not included in the remedial investigation/feasibility study process nor this ROD because previous investigations have shown that No Further Action (NFA) is required at these sites, which include Site SD023 (Pond 3 Area), Site SS092 (Building 786 Pesticide Storage), and Sites OT093, SS094, and SS095 (Polychlorinated Biphenyl [PCB] Sites). Two other sites, Site SD034 (Pond 1 Area) and Site SD040 (Pond 7 Area), that were previously closed with institutional controls (ICs) are addressed under separate decision documents. The U.S. Air Force evaluated remedial alternatives and selected monitored natural attenuation (MNA) and ICs for Site SS108 (800/900 Area), enhanced bioremediation and ICs for Site SS089 (1100 Area), and enhanced bioremediation, MNA, and ICs for Site SS090 (Golf Course Area).					
15. SUBJECT TERMS Record of Decision					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT ABSTRACT	18. NUMBER OF PAGES 158	19a. NAME OF RESPONSIBLE PERSON Sandra Staigerwald
a. REPORT UNCLASSIFIED	b. ABSTRACT UNCLASSIFIED	c. THIS PAGE UNCLASSIFIED			19b. TELEPHONE NUMBER (include area code) (385) 393-4982

THIS PAGE INTENTIONALLY LEFT BLANK

Hill Air Force Base, Utah
Performance-Based Remediation

Operable Unit 9
Record of Decision

Contract No: FA8903-09-D-8560
Task Order 0006

Prepared for:
Air Force Civil Engineer Center
2261 Hughes Avenue, Suite 163
JBSA Lackland Air Force Base, Texas 78326-9853

Prepared by:
EA Engineering, Science, and Technology, Inc., PBC
2363 N. Hill Field Road, Suite 104
Layton, Utah 84041

SEPTEMBER 2015

THIS PAGE INTENTIONALLY LEFT BLANK

Contents

	<u>Page</u>
Tables.....	iii
Figures	iii
Appendices.....	ii
Acronyms and Abbreviations	v
 1.0 Declaration.....	 1-1
1.1 Site Name and Location.....	1-1
1.2 Statement of Basis and Purpose	1-1
1.3 Assessment of Site	1-1
1.4 Description of Selected Remedies	1-1
1.4.1 Site SS108 (800/900 Area)	1-2
1.4.2 Site SS089 (1100 Area)	1-2
1.4.3 Site SS090 (Golf Course Area).....	1-2
1.5 Statutory Determinations	1-3
1.6 Data Certification Checklist.....	1-3
1.7 Authorizing Signatures	1-5
 2.0 Decision Summary.....	 2-1
2.1 Site Description and History	2-1
2.1.1 Operable Unit 9 Sites	2-1
2.1.2 History of Comprehensive Environmental Response, Compensation, and Liability Act Enforcement Activities.....	2-4
2.1.3 Federal Facility Agreement	2-4
2.1.4 Investigation History.....	2-4
2.1.5 Remedial Action History	2-4
2.2 Community Participation.....	2-6
2.3 Scope and Role of Operable Unit or Response Action	2-7
2.4 Site Characteristics	2-7
2.4.1 Location and Climate.....	2-7
2.4.2 Geology.....	2-7
2.4.3 Hydrogeology	2-8
2.4.4 Surface Water Hydrology	2-10
2.4.5 Ecology	2-10
2.4.6 Nature and Extent of Contamination	2-10
2.4.7 Fate and Transport of Contaminants.....	2-12

	<u>Page</u>
2.5	Current and Potential Future Land and Resource Uses 2-14
2.5.1	Institutional Controls 2-14
2.5.2	Land Use 2-15
2.5.3	Groundwater Use 2-15
2.6	Summary of Site Risks 2-16
2.6.1	Updated Risk Estimates 2-17
2.6.2	Final Contaminants of Concern 2-18
2.6.3	Basis for Response Action 2-19
2.7	Remedial Action Objectives 2-19
2.8	Description and Evaluation of Remedial Alternatives 2-20
2.8.1	Common Elements 2-21
2.8.2	Description of Remedial Alternatives 2-21
2.8.3	Distinguishing Features and Expected Outcomes of Remedial Alternatives 2-25
2.9	Summary of Comparative Analysis of Alternatives 2-25
2.9.1	Summary of Evaluation Criteria 2-25
2.9.2	Comparative Analysis of the Alternatives 2-26
2.10	Principal Threat Wastes 2-30
2.11	Selected Remedy 2-31
2.11.1	Institutional Controls 2-31
2.11.2	Site SS108 (800/900 Area) 2-34
2.11.3	Site SS089 (1100 Area) 2-35
2.11.4	Site SS090 (Golf Course Area) 2-36
2.12	Statutory Determinations 2-38
2.12.1	Protection of Human Health and the Environment 2-39
2.12.2	Compliance with Applicable or Relevant and Appropriate Requirements 2-39
2.12.3	Cost Effectiveness 2-40
2.12.4	Utilization of Permanent Solutions and Alternative Treatment Technologies 2-41
2.12.5	Preference for Treatment as a Principal Element 2-41
2.12.6	Five-Year Review Requirements 2-42
2.13	Documentation of Significant Changes 2-42
3.0	Responsiveness Summary 3-1
3.1	Overview 3-1
3.2	Background on Community Involvement 3-1
3.3	Summary of the Public Meeting and Public Comments 3-1

Page

4.0	References.....	4-1
-----	-----------------	-----

Tables

2-1	Previous Site Investigations and Remediation Activities at Operable Unit 9
2-2	Current Data Summary for Contaminants of Concern in Groundwater
2-3	Toxicity Factors
2-4	Exposure Factors
2-5	Risk Assessment Equations
2-6	Dermally Absorbed Dose Calculations
2-7	Risk Assessment Update Results
2-8	Data Summary for Contaminants of Concern in Soil for Site SS090 (Golf Course Area)
2-9	Summary of Remedial Components Evaluated for Operable Unit 9
2-10	Remedial Components for Site SS108 (800/900 Area)
2-11	Remedial Components for Site SS089 (1100 Area)
2-12	Remedial Components for Site SS090 (Golf Course Area)
2-13	Distinguishing Features of Remedial Alternatives for Site SS108 (800/900 Area)
2-14	Distinguishing Features of Remedial Alternatives for Site SS089 (1100 Area)
2-15	Distinguishing Features of Remedial Alternatives for Site SS090 (Golf Course Area)
2-16	Site SS108 (800/900 Area) Alternative Comparison
2-17	Site SS089 (1100 Area) Alternative Comparison
2-18	Site SS090 (Golf Course Area) Alternative Comparison
2-19	Summary of Applicable or Relevant and Appropriate Requirements for Selected Remedies

Figures

2-1	Operable Unit 9 – Installation Restoration Program Sites
2-2	Site SS108 (800/900 Area) Location Map
2-3	Site SS089 (1100 Area) Location Map
2-4	Site SS090 (Golf Course Area) Location Map
2-5	Regional Aquifer System Conceptual Model
2-6	Site SS090 (Golf Course Area) Source Zone Investigation Summary
2-7	Site SS090 (Golf Course Area) Cross Section A-A'
2-8	Site SS089 (1100 Area) Selected Remedy – Enhanced Bioremediation and Institutional Controls
2-9	Site SS090 (Golf Course Area) Selected Remedy – Limited Excavation, Enhanced Bioremediation, Monitored Natural Attenuation, and Institutional Controls

Appendices

A	Notice of Availability and Public Meeting Sign-in Sheet
B	Hill Air Force Base Operable Units and Extent of Operable Unit 9 Institutional Controls
C	Cost Estimate Summaries for the Selected Remedies

THIS PAGE INTENTIONALLY LEFT BLANK

Acronyms and Abbreviations

75 ABW	75 th Air Base Wing
µg/kg	Microgram(s) per kilogram
µg/L	Microgram(s) per liter
µg/m ³	Microgram(s) per cubic meter
ACACL	Alternate corrective action concentration limit
AF	Attenuation factor
AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
AFMC	Air Force Materiel Command
ARAR	Applicable or Relevant and Appropriate Requirement
bgs	Below ground surface
BRA	Baseline Risk Assessment
CA	Cost Analysis
cells/mL	Cell(s) per milliliter
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
cm/hr	Centimeter per hour
COC	Contaminant of concern
COPC	Contaminant of potential concern
CPT	Cone penetration test
CT	Carbon tetrachloride
CZOM	Environmental Operations Midwest Region Branch
DCE	Dichloroethene
DDE	Dichlorodiphenyldichloroethylene
DWRi	Division of Water Rights
EA	EA Engineering, Science, and Technology, Inc. (prior to 12 December 2014) or EA Engineering, Science, and Technology, Inc., PBC (12 December 2014 and thereafter)
EE	Engineering Evaluation
ELCR	Excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
ERM	ERM-Rocky Mountain, Inc.
ESD	Explanation of Significant Differences
Fm	Formation
FOD	Frequency of detection
FS	Feasibility study
ft	Feet(foot)
ft/ft	Feet(foot) per foot
ft/yr	Feet(foot) per year

GED	Groundwater extraction and direct discharge
GW	Groundwater
HI	Hazard index
HQ	Hazard quotient
hr	Hour
IC	Institutional control
IND	Industrial
INMRP	Integrated Natural Resources Management Plan
IRP	Installation Restoration Program
IWTP	Industrial Waste Treatment Plant
JA	Office of the Staff Judge Advocate Directorate
JBASA	Joint Base San Antonio
LDR	Land disposal restriction
max	Maximum
MCL	Maximum Contaminant Level
mg/kg	Milligram(s) per kilogram
mg/kg/day	Milligram(s) per kilogram per day
mg/L	Milligram(s) per liter
MNA	Monitored natural attenuation
MW	Montgomery Watson
MWH	Montgomery Watson Harza
NA	Not applicable
NAPA	North Area Preliminary Assessment
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	Non-detect
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFA	No Further Action
NFRAP	No Further Response Action Planned
O&M	Operation and maintenance
OSWER	Office of Solid Waste and Emergency Response
OU	Operable unit
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PM _{2.5}	Particulate matter less than 2.5 microns in diameter
PM ₁₀	Particulate matter less than 10 microns in diameter
POTW	Publically Owned Treatment Work
ppbv	Part(s) per billion by volume
PSVPlan	Performance Standard Verification Plan
RACT	Reasonably available control technology
RAO	Remedial action objective

RA-O	Remedial action-operations
RCRA	Resource Conservation and Recovery Act
RES	Residential
RfD	Reference doses
RG	Remediation goal
RI	Remedial investigation
ROD	Record of Decision
RSL	Regional Screening Level
SAPA	South Area Preliminary Assessment
SARA	Superfund Amendments and Reauthorization Act
SES	Select Engineering Services
SI	Site inspection
SVE	Soil vapor extraction
SVOC	Semivolatile organic compound
SWPPP	Stormwater pollution prevention plan
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TMV	Toxicity, mobility, or volume
TSCA	Toxic Substances Control Act
UAC	Utah Administrative Code
UCL	Upper confidence limit
UDEQ	Utah Department of Environmental Quality
UHC	Underlying hazardous constituent
UIC	Underground injection control
UPDES	Utah Pollutant Discharge Elimination System
USAF	U.S. Air Force
UST	Underground storage tank
UTS	Universal Treatment Standards
UU/UE	Unlimited use/unrestricted exposure
VE	Viable epidermis
VISL	Vapor Intrusion Screening Level
VOC	Volatile organic compound

THIS PAGE INTENTIONALLY LEFT BLANK

1.0 Declaration

1.1 Site Name and Location

Facility Name: Hill Air Force Base

Site Location: Davis and Weber Counties, Utah

CERCLIS ID Number: UT0571724350

Operable Unit/Site: Operable Unit 9

1.2 Statement of Basis and Purpose

This decision document presents the selected remedies for Installation Restoration Program (IRP) Sites SS108 (800/900 Area), SS089 (1100 Area), and SS090 (Golf Course Area) of Operable Unit (OU) 9, one of 15 OUs at Hill Air Force Base (AFB). This decision is based on the Administrative Record File for this site. Selected remedies were chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Status information for OU 9 can be found in the OU 9 Remedial Investigation (RI) Report (CH2M HILL 2005a), the Revised Feasibility Study (FS) Report (CH2M HILL 2010a), and the FS Supplement (EA Engineering, Science, and Technology, Inc., PBC [EA] 2014a). This Record of Decision (ROD) presents the final remedial actions for OU 9 and does not affect any other OUs.

This document is issued by the U.S. Air Force (USAF), which is the lead agency for cleanup actions at Hill Air Force Base (AFB), and by the U.S. Environmental Protection Agency (EPA) Region 8, which is the lead regulatory agency for CERCLA response actions at Hill AFB. Under CERCLA Section 120(e)(4)(A) and the NCP, the USAF and the EPA jointly select the remedy.

The State of Utah concurs with the selected remedy.

1.3 Assessment of Site

The response actions selected in this ROD are necessary to protect the public health, welfare, and the environment from actual or threatened releases of hazardous substances, pollutants, or contaminants from the OU 9 sites, which may present an imminent and substantial endangerment to public health or welfare.

1.4 Description of Selected Remedies

In addition to the three IRP sites (Sites SS108 [800/900 Area], SS089 [1100 Area], and SS090 [Golf Course Area]) of Operable Unit (OU) 9 addressed in this ROD, OU 9 also includes Site SD034 (Pond 1 Area) and Site SD040 (Pond 7 Area) that were previously closed with institutional controls (ICs). These two sites are addressed under separate decision documents. Site SD034 (Pond 1 Area) was investigated and a response action, including ICs, was completed under an Engineering Evaluation (EE)/Cost Analysis (CA) (CH2M HILL 2002a). An approved Action Memorandum Addendum (EA 2015a) presents a decision for additional actions to eliminate the need for ICs at the site. The actions will be documented in a Removal Action Report/Site Closeout Report. Site SD040 (Pond 7 Area) was determined to be a No Further Action (NFA) site following investigation, but also required ICs. Confirmatory groundwater

sampling was completed in October 2014 and documented in an approved No Further Response Action Planned (NFRAP) Decision Document Addendum (EA 2015b) to eliminate the need for ICs.

Five other sites in OU 9 are not included in the RI/FS process because previous investigations found that no further action was required at these sites. The NFA sites include:

- Site SD023 (Pond 3 Area)
- Site SS092 (Building 786 Pesticide Storage)
- Sites OT093, SS094, and SS095 (Polychlorinated Biphenyl [PCB] Sites).

Section 2.1 provides additional details regarding these sites.

Remedial alternatives for Sites SS108 (800/900 Area), SS089 (1100 Area), and SS090 (Golf Course Area) were developed and evaluated as part of the Revised FS Report (CH2M HILL 2010a) and FS Supplement (EA 2014a). The selected remedies are described in the subsections below. Based on these selected remedies, the overall cleanup strategy for OU 9 involves source management by soil removal and in situ enhanced bioremediation, in situ enhanced bioremediation and monitored natural attenuation (MNA) of groundwater, and exposure control until remedial action objectives (RAOs) are achieved through ICs.

1.4.1 Site SS108 (800/900 Area)

- MNA and confirmation sampling to verify that carbon tetrachloride (CT) concentrations remain below the Federal and Utah Maximum Contaminant Levels (MCLs) to support site closeout
- ICs will be maintained to prohibit groundwater use until the concentration of hazardous substances in groundwater are at such levels to allow for unlimited use/unrestricted exposure (UU/UE).

1.4.2 Site SS089 (1100 Area)

- Enhanced bioremediation by reductive dechlorination to treat TCE in the saturated zone through carbon substrate injection
- ICs will be maintained to prohibit groundwater use until the concentration of hazardous substances in groundwater are at such levels to allow for UU/UE.

1.4.3 Site SS090 (Golf Course Area)

- Enhanced bioremediation by reductive dechlorination to treat PCE and TCE in the unsaturated and saturated zones:
 - Limited excavation of shallow contaminated soil within the source area, offsite disposal of the excavated soil at a licensed disposal facility, and installation of a bioreactor in the excavation to provide in situ treatment of contaminated soil and groundwater in the source area
 - Carbon substrate injection in the saturated zone downgradient of the source area.

- MNA of PCE and TCE within the saturated and unsaturated zones outside the enhanced bioremediation treatment zone
- ICs will be maintained to prohibit groundwater use until the concentration of hazardous substances in groundwater are at such levels to allow for UU/UE.

1.5 Statutory Determinations

The selected remedies are protective of human health and the environment, comply with federal and state applicable or relevant and appropriate requirements (ARARs) of the remedial actions, are cost effective, and use permanent solutions and alternative treatment technologies to the maximum extent practicable.

The selected remedies at Sites SS089 (1100 Area) and SS090 (Golf Course Area) satisfy the statutory preference for treatment as principal elements of the remedies (i.e., reduce the toxicity, mobility, or volume [TMV] of hazardous substances, pollutants, or contaminants as a principal element through treatment). However, the remedy for Site SS108 (800/900 Area) does not satisfy the preference for treatment because further treatment of this site is not necessary because groundwater contaminant concentrations at the site are currently below the MCLs. Five other sites in OU 9 were not included in the RI/FS process because no further action was required at these sites. Two other sites that were previously closed with ICs are addressed under separate decision documents.

Because one or more of these remedies will result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for UU/UE, a statutory review will be conducted within 5 years after initiation of remedial action, and every 5 years following, to ensure that the remedy is, or will be, protective of human health and the environment. These five-year reviews will continue until UU/UE conditions are attained.

1.6 Data Certification Checklist

The following information is included in the decision summary section of this ROD:

- Contaminants of concern (COCs) and their respective concentrations (Section 2.4.6)
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater in the Baseline Risk Assessment (BRA) and ROD (Section 2.5)
- Baseline risk represented by the COCs (Section 2.6)
- Cleanup levels established for COCs and the basis for these levels (Section 2.7)
- Key factors that led to selecting the remedies (Section 2.9)
- Estimated capital, annual operation and maintenance (O&M), total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Section 2.9.2.7)
- How source materials constituting principal threats will be addressed (Section 2.10)

- Potential land and groundwater use that will be available at the sites because of the selected remedies (Section 2.11).

Additional information for these sites can be found in the Administrative Record file for OU 9, available online at the U.S. Air Force Civil Engineer Center, Air Force Administrative Record, <http://afcec.publicadmin-record.us.af.mil/>.


1.7 Authorizing Signatures

The USAF and EPA have jointly selected the remedies in this ROD for OU 9, Hill AFB, Utah. The State of Utah concurs with the selected remedies. Authorizing and support agency signatures are included on the following pages.

U.S. ENVIRONMENTAL PROTECTION AGENCY




MARTIN HESTMARK
Assistant Regional Administrator
Office of Ecosystems Protection and Remediation
U.S. Environmental Protection Agency Region 8



Date


STATE OF UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY



ALAN MATHESON
Executive Director
Utah Department of Environmental Quality

Sept. 24, 2015
Date

**U.S. AIR FORCE MATERIEL COMMAND
HILL AIR FORCE BASE, UTAH**



D. WADE LAWRENCE, Colonel, USAF
Vice Commander, 75th Air Base Wing

25 Sept 2015
Date

THIS PAGE INTENTIONALLY LEFT BLANK

2.0 Decision Summary

The decision summary identifies the selected remedies, explains how the remedies fulfill statutory and regulatory requirements, and provides a substantive summary of the Administrative Record file that supports the remedy selection decision.

2.1 Site Description and History

Hill AFB is located in northern Utah, approximately 30 miles north of Salt Lake City and approximately 7 miles south of Ogden. Hill AFB occupies approximately 6,700 acres within portions of Davis and Weber counties. Hill AFB has been the site of military activities since 1920, including distribution of military equipment, aircraft rehabilitation and maintenance, and missile assembly. A variety of ongoing industrial operations support the missions of Hill AFB, including metal plating, degreasing, paint stripping, painting, sanding, and other operations associated with aircraft, missile, and vehicle repair and maintenance. These industrial operations have generated numerous spent chemicals and wastes, including chlorinated and non-chlorinated solvents and degreasers, petroleum hydrocarbons, acids, bases, metals, and other chemicals.

OU 9 includes 10 IRP sites. Five of the sites (Sites SD023 [Pond 3 Area], SS092 [Building 786 Pesticide Storage], OT093, SS094, and SS095 [PCB sites]) were previously determined through investigation to be NFA sites and were not included in the complete RI/FS process. One site (Site SD034 [Pond 1 Area]) was investigated and a response action, including ICs, was completed under an EE/CA (CH2M HILL 2002a). An approved Action Memorandum Addendum (EA 2015a) presents a decision for additional actions to eliminate the need for ICs at the site. The actions will be documented in a Removal Action Report/Site Closeout Report. One site (Site SD040 [Pond 7 Area]) was determined to be an NFA site following investigation, but also required ICs. Confirmatory groundwater sampling was completed in October 2014 and documented in an approved NFRAP Decision Document Addendum (EA 2015b) to eliminate the need for ICs. The three remaining sites in OU 9 (Site SS108 [800/900 Area], Site SS089 [1100 Area], and Site SS090 [Golf Course Area]) (Figure 2-1) are included in this ROD.

As lead agency, the USAF has conducted environmental restoration at OU 9 in accordance with CERCLA under the Defense Environmental Restoration Program, which was established by Section 211 of SARA. The EPA Region 8 is the lead regulatory agency for CERCLA response actions at Hill AFB; the Utah Department of Environmental Quality (UDEQ) is a support agency, providing regulatory oversight. The USAF funds the remediation, and the Hill AFB Comprehensive Environmental Response, Compensation, and Liability Information (CERCLIS) Identification Number is UT0571724350 (EPA 2014a).

2.1.1 Operable Unit 9 Sites

The OU 9 sites are briefly described in this subsection.

2.1.1.1 Site SS108 (800/900 Area)

Site SS108 (800/900 Area) is located in an industrial area within Hill AFB (Figure 2-2) and consists of a CT plume in groundwater that has attenuated over time. Currently, CT concentrations are fluctuating at its MCL (5 micrograms per liter [$\mu\text{g/L}$]) in one monitoring well and below the MCL at all remaining monitoring wells at the site. Groundwater contamination associated with Site SS108 (800/900 Area) is suspected to be the result of the variety of industrial operations that have taken place over the years.

CT was used in Base operations from the 1940s to the 1950s (Montgomery Watson [MW] 1995), constraining the release to these dates. However, no other information about the CT release is available. There appears to be no continuing source of CT.

2.1.1.2 Site SS089 (1100 Area)

Site SS089 (1100 Area) is located near the western Base boundary north of the West Gate (Figure 2-3) and consists of a TCE plume in groundwater, which occupies approximately 8 acres (CH2M HILL 2005a). The plume originates on-Base and extends off-Base about 600 feet (ft) into Sunset City. Groundwater contamination associated with the site is suspected to have resulted from a variety of industrial operations performed over the years. TCE was used in Base operations from the 1940s to the 1960s, and was completely phased out by 1979 (MW 1995), constraining the release to these dates. However, no other information about the TCE release is available. There appears to be no continuing source of TCE.

2.1.1.3 Site SS090 (Golf Course Area)

Site SS090 (Golf Course Area) is located along the eastern Base boundary, at the east side of Hubbard Golf Course (Figure 2-4) and consists of PCE and TCE contamination in the unsaturated and saturated zones. These contaminant plumes originate near a former maintenance building that existed between 1943 and 1971 and was located approximately 200 ft north of the current maintenance building (CH2M HILL 2010a). Overflow of TCE dissolved in wastewater from a former catch basin south of the current maintenance building is believed to have been another source of TCE. Release of this TCE-contaminated wastewater likely occurred from the catch basin between 1971 and 1979, as this building was constructed in 1971, and large-scale use of TCE was discontinued Basewide in 1979 (CH2M HILL 2010a). The plumes extend to the south-southwest along the Base boundary. According to the OU 9 Performance Standard Verification Plan (PSVPlan) (Hill AFB 2012), the plumes occupy approximately 13 acres.

2.1.1.4 Site SD034 (Pond 1 Area)

Site SD034 (Pond 1 Area) is located along the southern boundary of Hill AFB, east of the South Gate entrance (Figure 2-1). Currently, this pond receives storm runoff from industrial areas and the flight line, which enters the pond at the northwest and northeast corners. This pond has been in existence since 1940 and received discharge from Berman Pond during times of overflow from high intensity storms. From 1940 to 1956, Berman Pond operated as an unlined evaporation pond, receiving stormwater runoff and industrial wastewater containing solvents, metals, and hydrocarbons as documented in the Engineering Evaluation/Cost Analysis for the OU 9 Pond 1 Removal Action (CH2M HILL 2002a). As a result, pond sediment was contaminated with fuel-related polycyclic aromatic hydrocarbons (PAHs), metals, and PCBs from historical storm runoff and industrial discharge from the industrial area of Hill AFB.

The contaminated sediment was part of a removal action in 2003, as described in Section 2.1.5. The contaminated sediment was consolidated and placed under a soil cover, which occupies approximately half an acre (CH2M HILL 2004a). Because the contaminated sediment is capped in place, UU/UE conditions have not been achieved, but only minimal ICs are required for this site. However, additional actions, including excavating the sediment for offsite disposal to eliminate the need for ICs at this site, are presented in an approved Action Memorandum Addendum (EA 2015a). The additional actions for Site SD034 (Pond 1 Area) will be documented in a Removal Action Report/Site Closeout Report.

2.1.1.5 Site SD023 (Pond 3 Area)

Site SD023 (Pond 3 Area) is located along the southern boundary of Hill AFB, west of the South Gate (Figure 2-1). Pond 3 has been a stormwater retention pond since 1957 and currently is designated as a wildlife habitat area. This pond receives stormwater runoff from the southern area of the Base via overflow from Pond 1 and from industrial areas north of this pond. Pond sediment has been impacted by PAHs and arsenic (CH2M HILL 2003). The PAH-contaminated sediment is located near the east and west pond inlets, and the metal-contaminated sediment was concentrated along the south bank, near the west end of the pond. PAHs were determined to be components of asphalt particles from neighboring parking lots and, therefore, did not require remedial action (CH2M HILL 2003). Arsenic-contaminated sediment was part of a removal action in 2003, as described in Section 2.1.5. The removal action was completed to residential regulatory standards, so UU/UE conditions have been achieved.

2.1.1.6 Site SD040 (Pond 7 Area)

Site SD040 (Pond 7 Area) is located in the southwest corner of the Base (Figure 2-1). Site SD040 encompasses Pond 7 and a small portion of a Clearfield City residential area located off-Base. The pond (formally known as Pond 6) was constructed in 1976 as a stormwater retention pond. Currently, the pond is used to collect stormwater runoff from on-Base areas north, east, and south of the pond. TCE in groundwater samples from one well slightly exceeded its MCL. Groundwater-related risks were determined to be below acceptable levels established by federal and state regulations, and the site achieved an approved NFRAP status in 2005 (CH2M HILL 2005b); although groundwater use restriction remains in place for this site. Additional groundwater sampling was conducted to confirm TCE concentrations in groundwater are below the MCL and eliminate the need for ICs at this site. The additional sampling at Site SD040 (Pond 7 Area) is documented in an approved NFRAP Decision Document Addendum (EA 2015b).

2.1.1.7 Site SS092 (Building 786 Pesticide Storage)

Site SS092 (Building 786 Pesticide Storage) is located on the north side of the Hill AFB airfield (Figure 2-1). Hill AFB began using the building for pesticide/herbicide storage in 1984 until it was demolished in 1997. Potential risk drivers consisted of pesticides/herbicides in soil (CH2M HILL 2002b). Pesticide-related risks were determined to be below acceptable levels established by federal regulations for residential use; UU/UE conditions have been met and the site received an NFA determination in 2002.

2.1.1.8 Sites OT093, SS094, and SS095 (PCB Sites)

The PCB sites associated with OU 9 consist of three IRP sites: Sites OT093 (Zone 9 Transformer Yard), SS094 (Building 2402), and SS095 (Building 2403). These sites are located in the central portion of Hill AFB (Figure 2-1). Soil was impacted by PCBs spilled from electrical transformers. Building 2402 and Building 2403 were constructed in the early 1960s and included transformer pads adjacent to the buildings. Site OT093 (Zone 9 Transformer Yard) was used as a storage area for used transformers (MW 1998). The PCB-impacted soil at each site was part of a removal action in 1999 (MW 1999) discussed further in Section 2.1.5. The removal action was completed to residential regulatory standards, so UU/UE conditions have been achieved at these sites.

2.1.2 History of Comprehensive Environmental Response, Compensation, and Liability Act Enforcement Activities

The USAF is managing remediation of contamination at OU 9 in accordance with CERCLA as required by the Defense Environmental Restoration Program. Because Hill AFB is on the National Priorities List and pursuant to CERCLA, the EPA Region 8, UDEQ, and USAF entered into a Federal Facility Agreement in April 1991. The purpose of the agreement was to establish a framework and schedule for developing, implementing, and monitoring appropriate remedial actions to address contamination at Hill AFB. The IRP is responsible for ensuring that appropriate CERCLA response alternatives are developed and implemented as necessary to protect public health, welfare, and the environment.

As far back as the 1970s, compliance with applicable environmental regulations has been a priority in the operation of Hill AFB. Since 1984, the USAF has committed significant resources to assess and remediate environmental contamination identified at Hill AFB. CERCLA established a national program for responding to releases of hazardous substances, pollutants or contaminants into the environment. In anticipation of CERCLA, the Department of Defense developed the IRP to respond to releases of toxic or hazardous substances at Department of Defense facilities. Hill AFB was already engaged in the IRP when it was placed on the CERCLA National Priorities List in July 1987.

SARA, enacted in 1986, requires that federal facilities follow the NCP. In addition, the program requires greater involvement and oversight of the EPA for federal facility cleanups. The IRP follows these requirements. In response to SARA, the EPA developed the Guidance for Conducting RIs and FSs under CERCLA (EPA 1988). This document was used as guidance for preparing the RI and FS Reports for OU 9. A Guide for Preparing Superfund Proposed Plans, RODs, and Other Remedy Selection Decision Documents (EPA 1999a) was used as guidance in preparing the Proposed Plan for OU 9 and this ROD.

2.1.3 Federal Facility Agreement

The USAF has conducted most of its environmental restoration activities at Hill AFB under the Federal Facility Agreement that was signed in April 1991 by the USAF, EPA Region 8, and UDEQ. The purpose of the agreement was to establish a framework and schedule for developing, implementing, and monitoring appropriate remedial actions at Hill AFB. The Federal Facility Agreement was signed pursuant to numerous authorities under relevant regulatory jurisdictions, including, but not limited to, CERCLA, the 1976 Resource Conservation and Recovery Act (RCRA), NCP, the Clean Water Act, and the Department of Defense Environmental Restoration Program.

2.1.4 Investigation History

Table 2-1 provides background information and summarizes the investigations conducted since 1993 that led to this ROD and describes CERCLA response actions undertaken at OU 9.

2.1.5 Remedial Action History

The OU 9 sites are in various stages of remediation (CH2M HILL 2005a and CH2M HILL 2010a). Remediation history for these sites is summarized in this section and is detailed further in Table 2-1. Figure 2-1 presents the location of the OU 9 sites. All sites have common ICs designed to prevent human exposure to contamination. The following paragraphs summarize the remedial action history for the three sites pending decisions on remedial actions:

- **Site SS108 (800/900 Area).** No interim remedies have been implemented. However, groundwater concentrations of CT have been monitored since 2003 and are currently fluctuating near the MCL. Groundwater monitoring continues to verify that CT concentrations remain below the MCL.
- **Site SS089 (1100 Area).** No interim remedies have been implemented. However, a treatability study for enhanced bioremediation was initiated in 2014 (EA 2014b). Additionally, before the North Area Site Inspection (SI), the USAF investigated, removed, and closed an underground storage tank (UST) near Building 1141 in the early 1990s as part of the UST Program (CH2M HILL 2005a).
- **Site SS090 (Golf Course Area).** No interim remedies have been implemented.

The rest of this section provides details on the remedial actions completed at the seven other OU 9 sites. Two of these sites, Site SD034 (Pond 1 Area) and Site SD040 (Pond 7 Area), were previously closed with ICs and are addressed under separate decision documents. Five other sites, which include Site SD023 (Pond 3 Area), Site SS092 (Building 786 Pesticide Storage), and Sites OT093, SS094, and SS095 (PCB Sites), were not included in the RI/FS process nor this ROD because previous investigations have shown that no further action is required at these sites. These sites are not carried through the Summary of Site Risk sections that focus on the three IRP sites pending decisions on remedial actions. A brief summary of remedial action history is presented below for the seven other OU 9 sites:

- **Site SD034 (Pond 1 Area).** The 2003 removal action was summarized in the Pond 1 Remedial Action Report (CH2M HILL 2004a). Contaminated sediment was consolidated and placed under a soil cover; and ICs were implemented following completion of an EE/CA (CH2M HILL 2002a) and associated Action Memorandum (CH2M HILL 2002c). The cleanup standards used for soil at the Pond 1 Area were the residential risk-based screening levels and site-specific background concentrations established in the South Area OU 9 SI (CH2M HILL 2001). Because contaminated sediment were capped in place, UU/UE conditions were not achieved and minimal ICs were required for this site. However, additional actions, including excavating the contained sediment for offsite disposal were approved under an Action Memorandum Addendum (EA 2015a) to achieve UU/UE conditions and eliminate the need for any ICs at this site. These additional actions will be documented in a Removal Action Report/Site Closeout Report.
- **Site SD023 (Pond 3 Area).** Following completion of an EE/CA (CH2M HILL 2003) and associated Action Memorandum (CH2M HILL 2004b), arsenic-contaminated sediment was removed and transferred to a solid waste landfill following waste characterization (CH2M HILL 2004c). The cleanup standard for arsenic (9.76 milligrams per kilograms [mg/kg]) in soil at the Pond 3 Area was a site-specific background concentration established as the mean concentration of background samples plus two standard deviations as presented in the South Area OU 9 SI (CH2M HILL 2001). In 2003, the site was closed under UU/UE conditions and declared by regulatory agencies to be available for any kind of use.
- **Site SD040 (Pond 7 Area).** Investigation was summarized in the NFRAP Decision Document (CH2M HILL 2005b). Groundwater was the only impacted medium, with TCE identified as the COC. Groundwater-related risks were determined to be below acceptable levels established by federal and state regulations, and Site SD040 (Pond 7 Area) was closed in 2005 with groundwater ICs. Confirmatory groundwater sampling was completed in October 2014 and documented in an approved NFRAP Decision Document Addendum (EA 2015b) to eliminate the need for ICs. The cleanup standard for groundwater at the Pond 7 Area was the applicable MCL.

- **Site SS092 (Building 786 Pesticide Storage).** Investigation was summarized in the NFRAP Decision Document (CH2M HILL 2002b). Pesticides/herbicides in soil were the COCs. Pesticide-related risks were determined to be below acceptable levels established by federal and state regulations for residential use, and the site was closed under UU/UE conditions in 2002. The cleanup standards used for soil at this site were the residential risk-based screening levels established in the South Area OU 9 SI (CH2M HILL 2001).
- **Sites OT093, SS094, and SS095 (PCB Sites).** These sites consist of Sites OT093 (Zone 9 Transformer Yard), SS094 (Building 2402), and SS095 (Building 2403). Interim response actions were documented in the PCB Removal Report for Buildings 2402 and 2403 and the Used Transformer Storage Yard (MW 1999). Contaminated soil was removed under the Toxic Substances Control Act, and the sites were closed under UU/UE conditions in 1999. PCB concentrations in soil confirmation samples collected following soil removal at each of these sites were below the Toxic Substances Control Act (TSCA) residential level of 1 mg/kg.

The remainder of this ROD documents remedial action decisions for Sites SS108 (800/900 Area), SS089 (1100 Area), and SS090 (Golf Course Area).

2.2 Community Participation

The USAF followed a remedy selection process in accordance with public participation requirements of CERCLA Sections 113(k)(2)(B)(i-iv) and 117. Additional requirements, as outlined in the Hill AFB Environmental Restoration Community Relations Plan (Hill AFB 1997), also were fulfilled. The USAF meets quarterly with members of the Hill AFB Restoration Advisory Board, which consists of approximately 25 people representing local communities; federal, state, county, and city governments; local sewer and water districts; civic, business, and environmental groups; the USAF, and other interested parties. Restoration Advisory Board meetings are advertised in local newspapers and are open to the public. Community concerns are solicited and addressed prior to making a final proposal for remedial action.

Upon completion of the RI/FS process, the USAF delivered RI/FS documents to federal and state agencies and the Administrative Record, available online at the U.S. Air Force Civil Engineer Center, Air Force Administrative Record, <http://afcec.publicadmin-record.us.af.mil/>. The Administrative Record file is open to the public.

- On 24 April 2014, the Proposed Plan for OU 9 (EA 2014c) was presented to the Restoration Advisory Board.
- On 24 September 2014, the notice of availability of the Proposed Plan was published in the Ogden Standard Examiner. A copy of the notice is included in Appendix A.
- On 1 October 2014, the Proposed Plan for OU 9 was presented to the public for comment and was delivered to the Administrative Record repository. The public comment period ran from 1 October to 31 October 2014.
- On 8 October 2014, an open house format public meeting was held at the Sunset City Offices in Sunset, Utah. Representatives from Hill AFB, the EPA, and UDEQ were present at the meeting. A sign-in sheet with the names of those in attendance at the public meeting also is included in Appendix A. No public comments were received on the Proposed Plan for OU 9.

2.3 Scope and Role of Operable Unit or Response Action

As with many large sites, environmental problems at Hill AFB are complex. As a result, the USAF, with approval from EPA Region 8 and concurrence from UDEQ, has organized the environmental restoration work at Hill AFB into 15 OUs, based upon geography, hydrogeology, and type of contaminated media. OUs 1 through 8 and OUs 12 and 13 have signed RODs. Consequently, remedial actions are operational at 10 of 15 Hill AFB OUs. Figure B-1 in Appendix B shows the locations of the Hill AFB OUs.

This ROD presents the selected remedies to address groundwater contamination at OU 9 Sites SS108 (800/900), SS089 (1100 Area), and SS090 (Golf Course Area), as well as soil contamination at Site SS090 (Golf Course Area). The USAF, with the Utah Division of Water Rights (DWRi), has already implemented ICs, which will be incorporated as a component of the selected remedies. Table 2-1 provides background information and summarizes the investigations conducted since 1993 that led to this ROD and describes CERCLA response actions undertaken at OU 9.

The USAF will continue stewardship of OU 9 after implementation of the selected remedies through monitoring the performance of remedial systems. If performance monitoring indicates that remedial actions are not performing as expected and are not achieving RAOs, the remedies will be re-evaluated.

2.4 Site Characteristics

This section describes conceptual site models for Sites SS108 (800/900 Area), SS089 (1100 Area), and Site SS090 (Golf Course Area) of OU 9, which includes the elements of geography, hydrogeology, contaminant nature and extent, and contaminant fate and transport. The information about these items presented herein is a summary of more detailed discussions in the RI and FS Reports (CH2M HILL 2005a and CH2M HILL 2010a).

2.4.1 Location and Climate

As previously stated, OU 9 is a compilation of various IRP Sites throughout Hill AFB. Figure 2-1 illustrates the locations of OU 9 IRP sites. Site SS108 (800/900 Area) is located in an industrial area of Hill AFB. Site SS089 (1100 Area) is located north of the West Gate along the western Base boundary. Site SS090 (Golf Course Area) is located along the eastern Base boundary and adjacent to the Hubbard Golf Course Area. The climate of Hill AFB is temperate and semi-arid.

2.4.2 Geology

2.4.2.1 Regional Geology

Hill AFB is located on the Paleo-Weber River Delta, a major geologic feature formed as the Weber River deposited sediment into ancient Lake Bonneville during the late Pleistocene Epoch, approximately 11,000 to 26,000 years ago. Sediment deposited during this period include the Alpine Formation (Fm) and the Provo Fm. The Alpine Fm underlies the entire project area at a thickness of approximately 70 to 500 ft and consists mainly of clays and silts with thin, fine-grained sand layers that tend to be laterally discontinuous. The Provo Fm overlies the Alpine Fm and generally consists of medium to coarse-grained sands with discontinuous gravel layers. Clay layers are also found within the Provo Fm but they tend to be laterally discontinuous (CH2M HILL 2005a).

2.4.2.2 Site SS108 (800/900 Area) Geology

Sediment underlying Site SS108 (800/900 Area) consist of unconsolidated Provo Fm deposits of gravel, sand, silty sand, sandy silts, and clay (CH2M HILL 2005a). These deposits are interbedded and are generally laterally discontinuous across the area. Sandy gravels, sand, and silty sand with thinly interbedded layers of silty clay characterize the upper 70 ft below ground surface (bgs) in the area. Below 70 ft bgs, sediment consists primarily of Alpine Fm clay and silt mixtures with thinly interbedded sand and silty sand layers that are laterally discontinuous.

2.4.2.3 Site SS089 (1100 Area) Geology

The Provo Fm is typically absent in the saturated zone. Unconsolidated deposits of Alpine Fm silt and clay with thinly interbedded layers of silty sands characterize the geology of Site SS089 (1100 Area) (CH2M HILL 2005a). The Alpine Fm at Site SS089 (1100 Area) is at least 80 ft thick. The silty sand layers are laterally discontinuous and are less than 1 ft thick. These layers dip toward the west and appear to follow surface topography.

2.4.2.4 Site SS090 (Golf Course Area) Geology

The Provo Fm is absent at Site SS090 (Golf Course Area). Five geologic units of the Alpine Fm have been characterized at Site SS090 (Golf Course Area). From the ground surface down, these five units consist of: an unsaturated silty clay up to approximately 45 ft thick that pinches out to the southwest; an upper fine-grained, saturated sand between 20 and 30 ft thick; an interbedded silty clay and silty sand aquitard between 25 and 35 ft thick; a lower, fine-grained silty sand approximately 5 to 10 ft thick that pinches out to the southwest; and a stiff clay aquitard at least 30 ft thick to a depth of at least 110 ft bgs (maximum depth drilled).

2.4.3 Hydrogeology

2.4.3.1 Regional Hydrogeology

At least 1,500 ft of unconsolidated sediment underlie Hill AFB (Feth et al. 1966). This sediment results from erosion of the Wasatch Mountains and deposition into the Lake Bonneville Basin, of which the Great Salt Lake is a remnant.

Three recognized aquifers comprise the groundwater system of Hill AFB: an unnamed shallow aquifer system, the Sunset Aquifer, and the Delta Aquifer. Groundwater production wells tap the Delta Aquifer, and less commonly, the Sunset Aquifer. Groundwater contamination at OU 9 is present in the upper 100 ft of the unnamed shallow aquifer (Figure 2-5). The shallow aquifer does not provide groundwater for potable use because of lower yields and poorer ambient water quality compared to the Sunset and Delta Aquifers. The Sunset and Delta Aquifers lie several hundred ft below the upper zone of the shallow aquifer system in which OU 9 plumes occur (CH2M HILL 2005a).

During replacement of Base Supply Well #5 and the drilling of an on-Base Clearfield City Well (Montgomery Watson Harza [MWH] 2001), approximately 250 to 450 ft of confining layers were documented to overlay the Sunset Aquifer, and additional confining layers were observed between the Sunset Aquifer and the Delta Aquifer. Consequently, contaminated groundwater is separated from the drinking water supplied by the Delta Aquifer by over 600 ft of sand and thick layers of low permeability silt and clay. These confining units hinder migration of contamination from the unnamed shallow aquifer to the Sunset and Delta Aquifers (Figure 2-5).

2.4.3.2 Site SS108 (800/900 Area) Hydrogeology

The hydrogeology consists of an unconfined system with a base corresponding to the top of a clay and silt layer at approximately 70 ft bgs. The topography and the horizontal hydraulic gradient gently slope to the southwest. The horizontal hydraulic gradient ranges from 0.01 to 0.05 foot per foot (ft/ft), with an average gradient of 0.02 ft/ft. The water table is approximately 35 to 40 ft bgs. No significant seasonal variations in groundwater elevations were noted in the RI Report (CH2M HILL 2005a).

The hydraulic conductivity, based on rising- and/or falling-head, in situ slug tests on four monitoring wells, ranges from 0.4 to 0.7 foot per day (ft/day) (CH2M HILL 2005a). A nearly flat horizontal hydraulic gradient and low horizontal hydraulic conductivity estimates give relatively slow groundwater velocity estimates of between 7.3 and 13 ft per year (ft/yr) to the southwest (CH2M HILL 2010a). Groundwater measurement taken in July 2003 showed that a majority of the wells have downward vertical hydraulic gradients ranging between 0.64 to 0.99 ft/ft, while one well (U9-605) exhibited a slight upward vertical hydraulic gradient of -0.18 ft/ft (CH2M HILL 2005a). Groundwater does not discharge to the surface in the area.

2.4.3.3 Site SS089 (1100 Area) Hydrogeology

The interbedded geology creates highly variable groundwater conditions that possibly include localized unconfined, semi-confined, and confined conditions. Depth to groundwater varies between approximately 3.5 and 37 ft bgs; no significant seasonal variations in groundwater elevations were noted in the RI Report (CH2M HILL 2005a).

The horizontal groundwater gradients in the area are to the west and range between 0.02 to 0.04 ft/ft, with an average gradient of 0.03 ft/ft. The hydraulic conductivity, based on rising- and/or falling-head, in situ slug tests on 24 monitoring wells screened at multiple depths, ranged from 0.03 to 13 ft/day (CH2M HILL 2005a). Groundwater velocity estimates range between 14 and 250 ft/yr (CH2M HILL 2010a). Groundwater does not discharge to the surface in the area.

2.4.3.4 Site SS090 (Golf Course Area) Hydrogeology

Groundwater conditions range from confined or semi-confined in the northeast where the overburden silty clay is thickest to unconfined in the southwest where the overburden clay pinches out. The groundwater potentiometric surface ranges from approximately 45 ft bgs in the north to a minimum of approximately 12 to 15 ft bgs in the central part of the site and increases to 25 to 30 ft bgs in the southwest. Despite seasonal irrigation at the golf course, seasonal groundwater fluctuations are minimal (CH2M HILL 2005a). Horizontal hydraulic gradients in the upgradient and central portions of the site range between 0.01 to 0.02 ft/ft. In the downgradient portion of the site, the horizontal groundwater gradients are higher, with a median hydraulic gradient of 0.047 ft/ft.

The hydraulic conductivity, based on rising- and/or falling-head, in situ slug tests on 13 monitoring wells screened at multiple depths, ranged from 0.09 to 48 ft/day (CH2M HILL 2005a). Groundwater velocity estimates of the plume-bearing layer (the upper fine-grained sand) range between approximately 110 and 160 ft/yr to the south in the upgradient and central portions of the site and between 1,500 and 1,800 ft/yr to the southwest in the downgradient portion of the site (CH2M HILL 2010a). Groundwater does not discharge to the surface in the area.

2.4.4 Surface Water Hydrology

The closest surface water body to Site SS108 (800/900 Area) is Pond 3, which is located 3,000 ft south of the site. The closest surface water body to Site SS089 (1100 Area) is the lined Davis-Weber Canal, which is located less than 100 ft west of the leading edge of the plume. Site SS108 (800/900 Area) and a portion of Site SS089 (1100 Area) are covered by impervious surfaces (e.g., parking lots, roads, and driveway). Stormwater at Sites SS108 (800/900 Area) and SS089 (1100 Area) either enters the on-Base stormwater drainage system or infiltrates pervious ground surfaces. Off-Base stormwater near Site SS089 (1100 Area) either enters Sunset City stormwater drainage system or infiltrates pervious ground surfaces. There are no surface water bodies at Sites SS108 (800/900 Area) or SS089 (1100 Area).

Stormwater at Site SS090 (Golf Course Area) infiltrates to the subsurface. There is no surface water body at Site SS090 (Golf Course Area). The closest surface water body to this site is a pond at the southern end of the golf course, which is located approximately 500 ft cross gradient from the groundwater contaminant plume.

2.4.5 Ecology

Animal species that may be present in the OU 9 area include reptiles, birds, and mammals, ranging from small rodents to medium-sized predators. According to the Hill AFB Integrated Natural Resources Management Plan (INMRP) (Select Engineering Services [SES] 2011), there are no known federal- or state-listed threatened or endangered species residing at Hill AFB.

2.4.6 Nature and Extent of Contamination

This section provides a summary of the nature and extent of contamination at Sites SS108 (800/900 Area), SS089 (1100 Area), and SS090 (Golf Course Area). Information provided includes summaries of the COCs, source information, and contaminated media.

2.4.6.1 Site SS108 (800/900 Area)

Site SS108 (800/900 Area) was investigated as part of the OU 9 South Area SI (CH2M HILL 2001) and the RI Report (CH2M HILL 2005a). These investigations resulted in delineation of a groundwater plume of CT, the sole COC at this site. Before re-evaluation in 2009, Site SS108 (800/900 Area) also included a TCE plume several hundred ft east of the CT plume and in a deeper geologic unit. Several lines of evidence support the conclusion that the TCE plume, which is in a deeper zone than the CT plume, is part of the OU 8 groundwater plume (CH2M HILL 2009a). The TCE plume beneath Site SS108 (800/900 Area) is being addressed as part of OU 8 (Site OT033). Therefore, TCE is not a COC at this site.

Soil samples were collected in the mid to late 1990s as part of the South Area SI (CH2M HILL 2001) near suspected source facilities at Site SS108 (800/900 Area). CT was not detected in these soil samples; therefore, there is no evidence of an ongoing source. Arsenic was detected in soil samples at concentrations that resulted in estimated risks within the NCP acceptable risk range (excess lifetime cancer risk [ELCR] between 1×10^{-4} and 1×10^{-6} and a hazard index [HI] less than 1). However, arsenic concentrations are below established background concentration for Hill AFB (CH2M HILL 2005a). Activities at this site are not believed to have contributed to arsenic concentrations in soil; the arsenic is naturally occurring.

Historical groundwater contamination at Site SS108 (800/900 Area) consists of CT detected at concentrations above the MCL (5 µg/L). The CT contamination, as defined by the 5-µg/L MCL, occurs within fine-grained sands from the water table at about 50 to 70 ft bgs to the top of a silty clay aquitard at 70 ft bgs. The historical CT plume measured approximately 900 ft wide (east to west) and 200 ft long (north to south), corresponding to a volume of approximately 19 million gallons of contaminated water (CH2M HILL 2005a). CT concentrations in groundwater above the MCL were restricted to Monitoring Well U9-014 (Figure 2-2), which has been in place since 2003. In July 2014, a CT concentration below the MCL was measured in a groundwater sample from Monitoring Well U9-014. The CT concentration time series plot (embedded in Figure 2-2) indicates natural attenuation is occurring at Site SS108 (800/900 Area). The observed CT concentrations in this well have declined from a maximum of 14.6 µg/L in April 2003 to 4.8 µg/L in July 2014.

2.4.6.2 Site SS089 (1100 Area)

Site SS089 (1100 Area) was investigated during the North Area SI (MW 2000), the RI (CH2M HILL 2005a), and in support of the Revised FS Report (CH2M HILL 2010a). These investigations resulted in delineation of a TCE plume, which is the sole COC at this site. Specific knowledge about activities that led to the presence of TCE in groundwater is not available.

TCE was not detected in soil and soil gas samples at Site SS089 (1100 Area) (CH2M HILL 2005a and CH2M HILL 2010a); therefore, there is no evidence for TCE in the unsaturated zone that could serve as an ongoing source of TCE in the groundwater.

Groundwater contamination at the Site SS089 (1100 Area) consists of a TCE plume approximately 1,000 ft long, 300 ft wide, and 50 ft thick with a depth constrained to about 60 ft bgs. The volume of contaminated groundwater within the plume was estimated as 27 million gallons in the RI Report (CH2M HILL 2005a). Groundwater preferentially flows westward along thin and laterally discontinuous, fine sand layers that are interbedded with silts and clays. Vertical migration is limited at approximately 60 ft bgs by an underlying clay unit. Figure 2-3 illustrates the location and estimated extent of groundwater contamination at the site. The maximum observed TCE concentration, measured in monitoring wells, was 81.9 µg/L in July 2014.

2.4.6.3 Site SS090 (Golf Course Area)

Site SS090 (Golf Course Area) was originally investigated as part of the North Area SI (MW 2000), the OU 11 RI/FS (CH2M HILL 2002d), the OU 9 RI (CH2M HILL 2005a), and in support of the Revised FS Report (CH2M HILL 2010a). The COCs at this site are PCE and TCE in soil and groundwater. Moreover, a source zone investigation in 2009 (CH2M HILL 2010b) provided the following interpretation: the PCE source appears to have been associated with solvent use at the former maintenance building, which existed between 1943 and 1971, approximately 200 ft north of the current maintenance building (Figure 2-6). The primary source of TCE appears to have been from biodegradation of PCE in the partially saturated soil beneath the former source. A former catch basin south of the current maintenance building may have been another source of TCE (MW 2000). Figure 2-4 illustrates the estimated extent of groundwater contamination at Site SS090 (Golf Course Area). Figures 2-6 and 2-7 illustrate lateral and vertical extent, respectively, of soil and soil gas contamination in the source area.

Soil and soil gas sampling were conducted to characterize the extent of PCE and TCE contamination in the unsaturated zone (Figures 2-6 and 2-7). Detections of PCE (and a trace of TCE) in soil gas samples were observed up to 70 ft away from the former maintenance building. Additionally, PCE and TCE were not detected at concentrations above applicable criteria in either soil or soil gas samples collected near the

former catch basin (Figure 2-6). The presence of limited detections of PCE and TCE in the soil and shallow soil gas samples only near the former maintenance building indicate that the soil in this area comprise the only ongoing source to groundwater (CH2M HILL 2010b).

Soil screening levels for Site SS090 (Golf Course Area) are based on the MCL-based screening levels for protection of groundwater, derived from the EPA Regional Screening Level table (EPA 2015), multiplied by an assumed dilution attenuation factor of 20. These screening levels are lower than residential exposure levels. The area of soil containing PCE above protection of groundwater criterion (i.e., more than 46 micrograms per kilogram [$\mu\text{g/kg}$]) is approximately 4,600 square ft with a thickness of approximately 45 ft (Figures 2-6 and 2-7). TCE soil contamination above protection of groundwater criterion (i.e., more than 36 $\mu\text{g/kg}$) occurs within the volume of the PCE soil contamination, with an approximate area of 500 square ft and a thickness of 20 ft. A maximum sample concentration of 1,600 $\mu\text{g/kg}$ of PCE and 150 $\mu\text{g/kg}$ of TCE was measured at a depth of 20 to 21 ft bgs at location U9-7673. The volume of contaminated soil was estimated as 158,000 cubic ft in the Revised OU 9 FS Report (CH2M HILL 2010a).

Groundwater contamination at Site SS090 (Golf Course Area) consists of comingled PCE and TCE plumes. Historically, cis-1,2-dichloroethene (DCE) was detected above its MCL of 70 $\mu\text{g/L}$. However, concentrations of cis-1,2-DCE in groundwater at this area have declined to below the MCL. HydroPunchTM samples were collected throughout the area in the mid-1990s through the early 2000s as part of the North Area SI (MW 2000), the OU 11 RI/FS (CH2M HILL 2002d), and the OU 9 RI Report (CH2M HILL 2005a). Additional HydroPunch samples were collected in 2009 to refine delineation of the lateral boundaries of the PCE plume (CH2M HILL 2010b). Generally, the HydroPunch sample data guided installation of monitoring wells. Approximate dimensions of the PCE plume are 750 ft long, 300 ft wide, and up to 20 ft thick. Approximate dimensions of the TCE plume are 2,000 ft long, 340 ft wide, and approximately 25 ft thick. The volume of contaminated groundwater within the plume areas was estimated at approximately 30 million gallons in the OU 9 PSVPlan (Hill AFB 2012). Historical maximum PCE and TCE concentrations observed were 1,100 $\mu\text{g/L}$ (September 2010) and 370 $\mu\text{g/L}$ (June 2011), respectively, from Monitoring Well U9-100. The highest PCE and TCE concentrations currently observed (June 2014) are 410 $\mu\text{g/L}$ and 110 $\mu\text{g/L}$, respectively, in the same well.

An interbedded unit consisting of mostly silty clay underlies the plume-bearing unit and has a maximum thickness of approximately 25 ft. The interbedded unit appears to limit downward migration of the groundwater contaminants. No PCE or TCE has been detected in samples collected from HydroPunch groundwater samples within or below the interbedded unit or from monitoring wells screened below the interbedded unit (CH2M HILL 2005a). These data constrain the depth of contamination to approximately 60 ft bgs, the maximum depth of the plume-bearing unit.

2.4.7 Fate and Transport of Contaminants

Contaminant transport is governed by source characteristics, physical and chemical properties of contaminants, site physical and geochemical conditions, and transport mechanisms. Data at the three OU 9 sites indicate that natural attenuation processes have stabilized or caused contraction of the plumes (CH2M HILL 2010a). Details regarding site-specific fate and transport are found in Section 1.6 of the Revised FS Report (CH2M HILL 2010a). Current groundwater COC concentrations from the three OU 9 sites continue to support the occurrence of natural attenuation and plume stability or contraction.

2.4.7.1 Site SS108 (800/900 Area)

At Site SS108 (800/900 Area), attenuation of the CT plume is apparent, as shown in the inset chart in Figure 2-2. Currently, CT concentrations are fluctuating around the MCL (5 µg/L) in one monitoring well and below the MCL at all remaining monitoring wells at the site. The exact mechanisms for natural attenuation at this site have not been determined. However, chloroform has been detected at Monitoring Well U9-014. Chloroform is a product of reductive dechlorination of CT under anaerobic conditions (CH2M HILL 2010a) suggesting reductive dechlorination is one mechanism for attenuation of CT at this site.

2.4.7.2 Site SS089 (1100 Area)

At Site SS089 (1100 Area), geochemical data collected since the mid-1990s establish the site aquifer as aerobic and oxidizing, and contaminant trend analyses indicate natural attenuation of TCE (CH2M HILL 2010a). Microbial enzyme probes indicate cometabolic enzymes are present and are sufficiently active to aerobically cometabolize TCE at five monitoring wells sampled (North Wind 2008), and the bulk aerobic and oxidizing geochemical conditions are consistent with widespread aerobic cometabolism of TCE. However, cis-1,2-DCE also has been detected in some monitoring wells, suggesting that anaerobic reductive dechlorination has occurred or is currently occurring in some localized anaerobic zones in the saturated zone. Vinyl chloride has generally not been detected.

A Thiessen polygon mass trend analysis was conducted and indicated the total mass of TCE declined by 2.6 pounds, or about 21 percent in 8 years. The resultant estimated degradation half-life (assuming first-order kinetics) is approximately 18 years (CH2M HILL 2010a). A degradation rate estimated from historical plume centerline data resulted in a degradation half-life of 25 ± 4 years. Biological data and consistency of estimated degradation rates imply that biodegradation mechanisms are operating (CH2M HILL 2010a). Plume stability has been demonstrated in the OU 9 PSVPlan (Hill AFB 2012) via plume map updates and estimates of TCE flux through a plane near the toe of the plume. No plume expansion has been observed over the past decade, and TCE mass flux at the toe of the plume did not exhibit any statistically significant trend. These observations indicate that the plume is stable and may be contracting.

The fate and transport of groundwater contaminants at Site SS089 (1100 Area) were further analyzed by numerical modeling, as detailed in Appendix G of the Revised FS Report (CH2M HILL 2010a). The numerical model for the saturated zone at this site was built using a code named MODFLOW-SURFACT, Version 3.0 (HydroGeoLogic 2006), in conjunction with the pre- and post-processing software Groundwater Vistas, Version 5.0 (Environmental Simulations Inc. 2007). Further details regarding parameters used in the model, model assumptions, or model construction are available in Appendix G of the Revised FS Report (CH2M HILL 2010a).

The fate and transport modeling estimated that the remedial timeframe for Site SS089 (1100 Area) under a no action scenario would be approximately 24 years (CH2M HILL 2010a). The plume was predicted to initially expand approximately 200 ft within the first 5 years, followed by a steady reduction in plume extent. The prediction of an initial plume expansion at Site SS089 (1100 Area) may have been a result of the assumed initial concentration distributions between the mobile and immobile domains; however, plume expansion has not been observed in the groundwater concentrations through 2013.

2.4.7.3 Site SS090 (Golf Course Area)

At Site SS090 (Golf Course Area), geochemical data collected since the late 1990s, including oxidation-reduction potential, dissolved oxygen concentration, and redox chemistry establish Site SS090 (Golf Course Area) aquifer as primarily aerobic and oxidizing (CH2M HILL 2010a). However, reductive dechlorination appears to be degrading PCE and TCE to cis-1,2-DCE in the unsaturated zone in the source area, and reductive dechlorination is also likely to occur in the finer-grained zones (i.e., immobile domain) of the saturated zone (CH2M HILL 2010a). Vinyl chloride has generally not been detected.

Genetic evidence and enzyme activity probe data demonstrate bacteria that produce enzymes capable of aerobic cometabolism of TCE are present and active in the saturated zone (CH2M HILL 2010a). Further, compound-specific isotope analyses showed delta Carbon-13 enrichment as PCE concentrations decreased and distance downgradient from the source increased, indicating biodegradation of organic compounds (CH2M HILL 2010a). Plume stability has been demonstrated in the OU 9 PSVPlan (Hill AFB 2012) via plume map updates and estimates of TCE and PCE plume mass and center of mass over time. Comparison of the plume shape over time has indicated that the TCE and PCE plumes have remained generally the same; however, the lateral extent of the plumes has retracted slightly.

The fate and transport of groundwater contaminants at Site SS090 (Golf Course Area) were further analyzed by numerical modeling, as detailed in Appendix G of the Revised FS Report (CH2M HILL 2010a). The numerical model for the saturated zone at this site was built using a code named MODFLOW-SURFACT, Version 3.0 (HydroGeoLogic 2006), in conjunction with the pre- and post-processing software Groundwater Vistas, Version 5.0 (Environmental Simulations Inc. 2007). HYDRUS-1D Version 4.14 (Simunek et al. 2008; van Genuchten 1974) also was used to model flow and transport of PCE through the source area in the unsaturated zone to the water table. HYDRUS-1D is a software package that numerically solves the Richards Equation for variably saturated flow and the advection-dispersion equation for solute transport in one dimension (i.e., vertical transport). Further details regarding parameters used in the model, model assumptions, or model construction are available in Appendix G of the Revised FS Report (CH2M HILL 2010a).

The fate and transport modeling (CH2M HILL 2010a) estimated that the remedial timeframe for Site SS090 (Golf Course Area) under a no action scenario would be approximately 75 years, and PCE concentrations directly below the source area were the limiting factor in achieving the MCL. The TCE concentrations in the saturated zone were predicted to reach its MCL in approximately 17 years. The PCE and TCE plumes were predicted to expand less than 500 ft during the first 5 years, followed by a steady reduction thereafter. The predicted initial plume expansion at Site SS090 (Golf Course Area) has not been observed in the groundwater concentrations through 2013.

2.5 Current and Potential Future Land and Resource Uses

2.5.1 Institutional Controls

Groundwater use restrictions established by the Utah DWRi prohibit new wells in the shallow aquifer system in off-Base areas near Hill AFB, which includes areas of groundwater impacted by contaminants at OU 9. The USAF restricts domestic use of shallow groundwater in on-Base areas impacted by contaminants at OU 9. The extent of ICs associated with the OU 9 sites is shown in Figure B-2 in Appendix B. Section 2.11.1 includes additional details about IC implementation.

2.5.2 Land Use

2.5.2.1 Current Onsite Land Uses

Current land use of Sites SS108 (800/900 Area) and SS089 (1100 Area) are primarily industrial. The buildings that occupy the land overlying Site SS108 (800/900 Area) plume support aircraft maintenance (MW 1994). Vehicle maintenance, fuel and oil storage, and utility (carpentry, electrical, and plumbing) buildings have occupied the on-Base land overlying Site SS089 (1100 Area) plume (MW 1995). Off-Base, the Site SS089 (1100 Area) plume underlies Union Pacific Railroad right-of-way and Interstate-15. Most of the land use at Site SS090 (Golf Course Area) is recreational. Maintenance of golf course equipment in the current maintenance building (Figure 2-4) constitutes some industrial land use.

2.5.2.2 Current Adjacent Land Uses

The plume of Site SS108 (800/900 Area) is within the Hill AFB boundaries and all land adjacent to the area overlying the plume is industrial. At Site SS089 (1100 Area), land adjacent to the area overlying the plume on-Base is either vacant or industrial as illustrated in Figure 2-3. Off-Base at Site SS089 (1100 Area), land adjacent to the area overlying the plume is commercial. Off-Base land adjacent to and east of Site SS090 (Golf Course Area) is vacant and zoned for Light Manufacturing/Industrial use (Layton City 2015a). Lands adjacent to Site SS090 (Golf Course Area) to the north and to the west are within the Base boundaries and are recreational. Lands adjacent to Site SS090 (Golf Course Area) to the south and southwest are within the Base boundaries and are vacant.

2.5.2.3 Reasonably Anticipated Future Land Uses

According to the Hill AFB Base Comprehensive Plan, the long-term future land use for Site SS108 (800/900 Area) and adjacent lands will remain industrial based on the proximity of this site to the flight line. The on-Base land of Site SS089 (1100 Area) may become part of a non-military business park because of the West Side Development Enhanced Use Lease project. New development would change the land use near this site from industrial to commercial. Off-Base near Site SS089 (1100 Area) in Sunset, land use scenarios are unlikely to change (Sunset City Planning Commission 2012). According to the Hill AFB Base Comprehensive Plan, the long-term future land use for Site SS090 (Golf Course Area) will remain recreational with industrial use at the maintenance shop. Layton City (Layton City 2015b) is planning an Industrial/Business Park adjacent to the eastern border of Hill AFB, including the currently vacant lands east of Site SS090 (Golf Course Area).

2.5.3 Groundwater Use

The shallow aquifer is not currently used as a potable water source by either Hill AFB or the surrounding communities; however, Utah law requires consideration of the shallow aquifer for future potable use. Under Rule R317-6-3 (Groundwater Classes) of the Utah Administrative Code (UAC), the uncontaminated groundwater of the shallow aquifer would be Class II—Drinking Water Quality Groundwater based upon the background total dissolved solids concentrations that range from generally greater than 500 milligrams per liter to less than 3,000 milligrams per liter. Rule R317-6-4 (Groundwater Class Protection Levels) of the UAC stipulates, “Class II groundwater will be protected for use as drinking water or other similar beneficial use with conventional treatment before use.” By these classifications and protection levels, the State of Utah considers the shallow aquifer to be of potentially beneficial use. Although the shallow aquifer is currently not used, the potentially beneficial use mandates risk assessment under future potable water-use exposure scenarios. The stable plumes imply that the groundwater plumes will not affect the shallow aquifer downgradient of the current plume boundaries.

2.6 Summary of Site Risks

The BRA process summarizes potential human-health and ecological risks and hazards under baseline conditions (i.e., assuming no remedial actions are taken and no risk management strategies [ICs] are in place) for current and hypothetical future exposure scenarios. It provides the basis for taking action and identification of COCs. Risks to human and ecological receptors from potential exposure to contaminants in the media at Sites SS108 (800/900 Area), SS089 (1100 Area), and SS090 (Golf Course Area) were originally evaluated in the OU 9 RI Report (CH2M HILL 2005a). Additionally, soil and soil gas data were collected at Sites SS089 (1100 Area) and SS090 (Golf Course Area) in 2009 to complete the OU 9 site characterization and support remedial decision making (CH2M HILL 2010b). The Revised FS Report (CH2M HILL 2010a) presented a risk screening for the 2009 soil and soil gas data.

Based on findings in the approved RI Report and Revised FS Report, the OU 9 COCs discussed further in the risk summary include:

- CT in groundwater at Site SS108 (800/900 Area)
- TCE in groundwater at Site SS089 (1100 Area)
- PCE and TCE in groundwater and in soil (protection of groundwater pathway) at Site SS090 (Golf Course Area).

Following finalization of the OU 9 RI Report, monitoring of groundwater contaminants continued at these sites. After the completion of the Revised FS Report, the EPA revised toxicity factors for PCE and TCE. The EPA also recently revised other exposure parameters inherent in the risk assessment process, such as body weight, exposure durations, and tap water ingestion rates (EPA 2014b). Therefore, updated risk estimates were prepared for this ROD to present an evaluation utilizing more recently collected site data, current toxicity values, and current exposure parameters. An update was not conducted for protection of groundwater pathway at Site SS090 (Golf Course Area) because no new soil data have been collected, and there have been no changes to underlying water quality criteria (MCLs) or physical properties of PCE and TCE (e.g., organic carbon partitioning coefficients).

The OU 9 RI Report (CH2M HILL 2005a) included an evaluation of ecological risks and concluded:

- There are no known federal- or state-listed threatened or endangered species residing at OU 9.
- Higher trophic level wildlife receptors did not warrant evaluation due to small size of the sites and lack of habitat.
- While several inorganic constituents could not be excluded from posing potential risks to soil invertebrates and terrestrial plants, there was no evidence that these constituents are attributable to site releases at Sites SS108 (800/900 Area), SS089 (1100 Area), and SS090 (Golf Course Area).

Since there have been no changes in land use that would warrant revisiting these findings, and none are expected, ecological risks are not a factor in selecting remedies for the OU 9 sites. Thus, the following summary focuses on human health risks only.

2.6.1 Updated Risk Estimates

Updated risk estimates were prepared to capture recent groundwater monitoring data and changes in EPA toxicity and exposure factors. Updated groundwater concentrations for use in the risk assessment update consist of the maximum detected concentrations of the site-specific COCs from samples collected between July 2012 and July 2014. The data were extracted from the Hill AFB Environmental Resources Program Information Management System (ERPIMS) database. Table 2-2 summarizes updated groundwater COC concentrations used on the risk assessment update.

In addition to the COCs discussed above, PCE in soil gas at Site SS090 (Golf Course Area) was included in this update because cancer risks greater than 10^{-5} were previously calculated for the soil gas to indoor-air pathway (CH2M HILL 2010a). There are no more recent soil gas data.

EPA's Integrated Risk Information System (IRIS) database was updated in 2011 for TCE and in 2012 for PCE. The updates included the following toxicological factors:

- Carcinogenic effects
 - Oral slope factors
 - Inhalation unit risk factors
- Non-carcinogenic effects
 - Oral reference doses
 - Inhalation reference concentrations.

Table 2-3 summarizes the current IRIS toxicity factors for PCE and TCE. EPA also updated exposure factors in 2014 and the relevant updated factors are shown in Table 2-4. The risk estimates were updated using forward risk calculations. Tables 2-5 and 2-6 summarize the applicable variables and equations, which are consistent with the most current risk assessment guidance documents (EPA 1989; EPA 2004; EPA 2009; EPA 2014b).

Table 2-7 summarizes the updated risk estimates, which are further distilled below and presented in comparison to the NCP, acceptable non-cancer HI (1) and cumulative ELCR range (10^{-6} to 10^{-4}).

- Site SS108 (800/900 Area) groundwater as tap water
 - Analyte: CT
 - HI = 0.08 (below NCP criterion, no further evaluation of noncancer hazards warranted)
 - Cumulative ELCR = 1×10^{-5} (within NCP risk range, the concentration of CT is currently fluctuating at its 5 µg/L MCL, therefore, it will be retained as a COC)
- Site SS089 (1100 Area) groundwater as tap water
 - Analyte: TCE
 - HI = 30 (above NCP criterion, TCE remains a COC based on noncancer hazards)
 - Cumulative ELCR = 2×10^{-4} (above NCP risk range, TCE remains a COC based on cancer risk)
- Site SS090 (Golf Course Area) groundwater as tap water
 - Analytes: PCE and TCE
 - HI = 50 (above NCP criterion, PCE and TCE remain COCs based on noncancer hazards)
 - Cumulative ELCR = 3×10^{-4} (above NCP risk range, PCE and TCE remain COCs based on cancer risk)

- Site SS090 (Golf Course Area) soil gas to future hypothetical residents via vapor intrusion
 - Analyte: PCE
 - HI = 0.6 (below NCP criterion, no further evaluation of noncancer hazards warranted)
 - Cumulative ELCR = 2×10^{-6} (within NCP risk range, further evaluation warranted, see below discussion in this section).

ELCR values were compared to the risk management range of 1×10^{-6} to 1×10^{-4} , where 1×10^{-6} is considered the point of departure for risk management decisions regarding direct contact with contaminated soil or groundwater. ELCR values within the 1×10^{-6} to 1×10^{-4} range involve a risk management decision that includes evaluating site-specific characteristics and exposure scenario factors to assess whether remedial action is warranted for reasons related to human health risk assessment (as opposed to ARARs). The NCP preamble further clarifies this as follows (emphasis added):

Preliminary remediation goals for carcinogens are set at a 10^{-6} excess cancer risk as a point of departure, but may be revised to a different risk level within the acceptable risk range based on the consideration of appropriate factors including, but not limited to: exposure factors, uncertainty factors, and technical factors. Included under exposure factors are: the cumulative effect of multiple contaminants, the potential for human exposure from other pathways at the site, population sensitivities, potential impacts on environmental receptors, and cross-media impacts of alternatives. Factors related to uncertainty may include: the reliability of alternatives, the weight of scientific evidence concerning exposures and individual and cumulative health effects, and the reliability of exposure data. Technical factors may include: detection/quantification limits for contaminants, technical limitations to remediation, the ability to monitor and control movement of contaminants, and background levels of contaminants. The final selection of the appropriate risk level is made when the remedy is selected based on the balancing of criteria.

Regarding PCE in soil gas at Site SS090 (Golf Course Area), the Base has utilized Mitigation Action Levels based on a target ELCR of 1×10^{-5} in managing potential actions related to vapor intrusion as part of the Indoor Air Program (MWH 2004). The estimated soil gas to indoor air cancer risk of 2×10^{-6} is below the target ELCR and corresponds to the lower end of the NCP acceptable range. Considering these factors along with (1) the numerous levels of conservatism inherent in the risk calculations and (2) the unlikelihood of future residential development at Site SS090 (Golf Course Area), the likelihood of complete, unacceptable, future hypothetical residential vapor intrusion exposures is very low. Additionally, achievement of the soil remediation goals (RGs) for Site SS090 (Golf Course Area) (Section 2.7) would result in lower contaminant concentrations in the source area and reduce potential vapor intrusion risks. Also, the five-year review process would identify changes in potential land use and associated vapor intrusion exposures. For these reasons, retention of PCE as a COC in soil gas at Site SS090 (Golf Course Area) is not warranted.

2.6.2 Final Contaminants of Concern

Based on the results and analysis provided above and the ARAR evaluation (Sections 2.7 and 2.8.3), the final COCs include:

- CT in groundwater at Site SS108 (800/900 Area)
- TCE in groundwater at Site SS089 (1100 Area)

- PCE and TCE in groundwater and in soil (protection of groundwater pathway) at Site SS090 (Golf Course Area).

2.6.3 Basis for Response Action

The response actions selected in this ROD are necessary to protect the public health or welfare or the environment from actual or threatened releases of pollutants or contaminants into the environment. Based on available information, risks to human health due to direct exposures to contaminants in OU 9 soil, as documented in the OU 9 RI Report (CH2M HILL 2005a) and the OU 9 Revised FS Report (CH2M HILL 2010a), are incomplete or insignificant (i.e., less than a target risk equal to 1×10^{-6} and less than a target HI of 1). Likewise, the estimated hypothetical future risks to human health due to secondary exposure to soil and groundwater contaminants (through vapor intrusion) at Sites SS108 (800/900 Area) and SS089 (1100 Area) are negligible (CH2M HILL 2010a). Estimated hypothetical future risks to human health due to secondary exposure to soil and groundwater contaminants (through vapor intrusion) at Site SS090 (Golf Course Area) are below a HI of 1 and are just slightly greater than the lower (1×10^{-6}) end of the acceptable cancer risk range. For reasons outlined in Section 2.6.1, these values do not constitute an unacceptable risk for future receptors at the site.

Estimated cancer risk due to site-related chemicals for hypothetical future residential groundwater use at Site SS108 (800/900 Area) are within the NCP acceptable range of 1×10^{-6} to 1×10^{-4} . However, because concentrations of CT have slightly exceeded its 5 µg/L MCL over the past 2 years at Site SS108 (800/900 Area), remedial action is necessary. Non-cancer hazards for potential future residents exposed to site-related chemicals in groundwater via the drinking-water-use scenario also exceeded the acceptable HI of 1 and cancer risk of 1×10^{-4} at Site SS090 (Golf Course Area) for PCE and TCE and Site SS089 (1100 Area) for TCE, indicating a need for remedial action.

A key factor to consider is that groundwater contamination at each OU 9 area exceeds MCLs for the same chemicals that are resulting in risks or hazards within or above EPA targets. Thus, achieving MCLs (i.e., compliance with ARARs) was a main goal in assessing and selecting remedies, as described in Sections 2.8 through 2.11. Soil concentrations in the source area at Site SS090 (Golf Course Area) warrant remedial action to remove this potential ongoing source of PCE and TCE groundwater contamination (above the 5-µg/L MCL).

2.7 Remedial Action Objectives

To protect human health and address potential future risks based on current and reasonably anticipated future land use of Hill AFB and Sunset City, the following RAOs were established for OU 9 (CH2M HILL 2010a).

- **Remedial Action Objective 1:** Prevent human exposure to contamination above RGs through contact or ingestion of contaminated groundwater.

Note: Although potential future exposure to VOCs via the vapor intrusion pathway was stated as part of RAO 1 in the Revised FS Report (CH2M HILL 2010a), the updated evaluation presented herein concludes that no COCs were identified for evaluation of the vapor intrusion pathway at each of the OU 9 sites. As a result, RAO 1 is stated as presented above.

- **Remedial Action Objective 2:** Remediate contamination in groundwater to concentrations below MCLs within a reasonable timeframe.

Note: Given the hydrogeological setting and current available remedial technologies, restoration timeframes of 50 to 100 years are anticipated and considered reasonable.

- **Remedial Action Objective 3:** Prevent further degradation of groundwater.
- **Remedial Action Objective 4:** Prevent further vertical migration of COCs from the unsaturated zone soil in the source area to the saturated zone at Site SS090 (Golf Course Area).

The baseline risk assessment concluded there are no significant ecological risks at OU 9 (CH2M HILL 2005a).

These RAOs were developed based on current and reasonably anticipated future land uses of Hill AFB and neighboring cities, as well as potential beneficial use of groundwater as described in Section 2.5.3. These RAOs led to development of remedial alternatives (Section 2.8) to accomplish RGs, which are site-specific, quantitative goals that define the extent of cleanup required to meet the RAOs. RGs are presented in Tables 2-8 and 2-9, as well as Section 2.11, which details the selected remedies and expected outcomes of remediation at each site.

Chemical-specific ARARs, (e.g., MCLs) exist for groundwater COCs at the sites and serve as the groundwater RGs. The Federal and Utah MCLs are equivalent for the COCs at these sites. RGs for soil at Site SS090 (Golf Course Area) are based on the EPA RSLs for the protection of groundwater (EPA 2015) (Table 2-8). The tabulated protection of groundwater RSL values are based on limiting migration of unsaturated zone contaminants that could result in groundwater contamination exceeding the MCL or other applicable risk-based concentration in groundwater. The tabulated RSLs assume no dilution exists between soil pore water and groundwater. However, attenuation processes in the unsaturated zone, such as adsorption and degradation, generally reduce soil leachate concentrations. Therefore, consistent with EPA guidance (EPA 1996), a dilution attenuation factor of 20 was applied to derive the soil RGs for PCE and TCE as 46 and 36 µg/kg, respectively.

Finally, these RAOs address the risks identified in the risk assessment without consideration of ICs which prevent human exposure to contaminated groundwater and soil. Groundwater use restrictions established by the Utah DWRi prohibit new wells in the shallow aquifer system in off-Base areas near Hill AFB, which includes areas of groundwater impacted by contaminants at OU 9. The USAF restricts domestic use of shallow groundwater in on-Base areas impacted by contaminants at OU 9.

2.8 Description and Evaluation of Remedial Alternatives

Remedial alternatives were developed during the FS process to meet the RAOs. These remedial alternatives consist of various combinations of remedial components to address the nature and extent of contamination and site conditions of each plume. A brief description of these remedial components is provided in Table 2-9. This section summarizes each evaluated remedial alternative by first discussing those common remedial components of all remedial alternatives, then by describing the components of each evaluated alternative for each of the areas. Finally, this section compares the distinguishing features of the remedies for each area.

As part of the FS process, specific process options were assumed for some remedial alternatives. These process options were used to develop initial cost estimates and numerical model implementation and performance. The process options presented in the FS and described herein are not intended to exclude other possible options within a general type of remedial technology. Specifically, other process options that may perform comparably for a remedial alternative may be considered during the remedial design

phase, including innovative technologies. If other process options are selected during the remedial design phase, major changes may be documented in the form of a memorandum in the Administrative Record file, an Explanation of Significant Differences (ESD), or a ROD Amendment.

2.8.1 Common Elements

Common remedial components to the remedial alternatives (except for the No Action Alternative) include:

- Remedial action-operations (RA-O) performance monitoring
- Continuation of ICs.

2.8.1.1 Remedial Action-Operations Performance Monitoring

A RA-O Performance Monitoring Plan will track progress toward achieving RAOs. Performance evaluation of the approved remedies will be presented in a Remedial Design/Remedial Action Work Plan that will be prepared for each site.

2.8.1.2 Continuation of Institutional Controls

ICs are used to mitigate risks to human health and the environment when contamination remains at OU 9 (on-Base and off-Base) at concentrations that preclude unrestricted land or groundwater use. As such, ICs are a key strategy for achieving RAO 1 by preventing groundwater use. The USAF is responsible for implementation, monitoring, maintenance, reporting on, and enforcement of the on-Base ICs. The USAF's implementation of on-Base ICs also includes specific actions described in the Base General Plan to restrict disturbance of soil, groundwater, and remedial systems on Base property as displayed on the Restricted Areas Use Map. If the USAF and EPA determine that specific IC requirements are not being met, it is understood that the remedy may be reconsidered and that additional measures may be required to ensure the protection of human health and the environment. Accordingly, the Utah DWRi prohibits new wells in the shallow aquifer system in off-Base areas around Hill AFB. The USAF will send a letter to the Utah DWRi annually requesting verification of continuing enforcement of these restrictions throughout the life of the remedy, though the USAF will ultimately be responsible for maintaining the integrity of the remedy. Section 2.11.1 provides further details about the implementation of ICs.

2.8.2 Description of Remedial Alternatives

2.8.2.1 Site SS108 (800/900 Area) Remedial Alternatives

The following four remedial alternatives were presented in the Revised FS Report (CH2M HILL 2010a) for remediation of the CT plume at Site SS108 (800/900 Area):

- Alternative 1 – No Action
- Alternative 2 – MNA and ICs
- Alternative 3 – In situ chemical oxidation, MNA, and ICs
- Alternative 4 – Groundwater extraction and discharge, MNA, and ICs.

Historically, CT concentrations in groundwater at Site SS108 (800/900 Area) above the Federal and Utah MCLs of 5 µg/L have been limited to one monitoring well (U9-014) (Figure 2-2). As shown on the inset chart on Figure 2-2, the CT concentration in this well has declined to below the MCL. Trend analysis of the detected CT concentrations in Monitoring Well U9-014 indicate a decreasing trend at the 95 percent significance level. Concentrations of CT in groundwater samples collected from other monitoring wells

at the site have been below the MCL over a period of up to 11 years. As a result, only verification monitoring is required to demonstrate that the RAOs have been achieved and Alternatives 3 and 4 are not considered further. Brief descriptions of the remaining alternatives are included in this subsection.

Site SS108 (800/900 Area) Alternative 1 – No Action. Alternative 1 is intended to serve as a baseline for evaluating other alternatives as required by the NCP. No further action would be taken. Under this alternative, existing ICs would not be renewed.

Site SS108 (800/900 Area) Alternative 2 – Monitored Natural Attenuation and Institutional Controls (Preferred Alternative). Alternative 2 includes maintaining ICs in place while monitoring the groundwater to confirm that the concentration of CT remains below the MCL to support site closeout. The RAOs would be considered met following 2 years of confirmation sampling data indicating that the concentration of CT in groundwater remains below the MCL. The estimated time required to obtain RAOs is approximately 2 years.

Alternatives 3 and 4 are not expected to produce reduction in the remedial timeframe and are not considered further. Therefore, only Alternatives 1 and 2 are applicable and were included in the OU 9 Proposed Plan. Table 2-10 summarizes components of each remedy and Figure 2-2 shows the sampling location for Alternative 2.

2.8.2.2 Site SS089 (1100 Area) Remedial Alternatives

Four remedial alternatives were presented in the Revised FS Report (CH2M HILL 2010a) for remediation of the TCE plume at Site SS089 (1100 Area). To accelerate site closeout, a fifth alternative was presented in the OU 9 FS Supplement (EA 2014a). Table 2-11 summarizes the components of each alternative. Brief descriptions of each alternative include:

Site SS089 (1100 Area) Alternative 1 – No Action. Alternative 1 consists of taking no further action. Existing ICs would not be renewed. This alternative serves as a baseline for evaluating other Site SS089 (1100 Area) proposed alternatives as required by the NCP.

Site SS089 (1100 Area) Alternative 2 – Existing Phytoremediation, Monitored Natural Attenuation, and Institutional Controls. This alternative consists of the continuation of existing phytoremediation, groundwater monitoring, and ICs. Mature poplars located at the site would continue to remove and treat TCE. MNA and ICs would continue until the remedy achieves RAOs. It is estimated that the RAOs would be met in approximately 24 years.

Site SS089 (1100 Area) Alternative 3 – Enhanced Phytoremediation, Monitored Natural Attenuation, and Institutional Controls. Alternative 3 consists of enhancing phytoremediation through the installation of a tree farm, ICs, and MNA. The tree farm would be located along the east side of the Hill AFB boundary. The tree farm was assumed to cover a total area of about 0.7 acre and consist of approximately 300 hybrid poplar trees, though adjustments could occur during the design phase. Remediation of the plume downgradient of the tree farm would be by MNA. The RAOs would be met in approximately 20 years based upon mass-uptake calculations detailed in the Revised FS Report.

Site SS089 (1100 Area) Alternative 4 – Groundwater Extraction and Discharge, Existing Phytoremediation, Monitored Natural Attenuation, and Institutional Controls. Alternative 4 consists of installing groundwater extraction wells with the objective of reducing contaminant mass and remedial timeframe. Numerical modeling of this alternative for the Revised FS Report concluded that three extraction wells discharging at a combined rate of 5 to 10 gallons per minute optimized performance of the remedy. Further analysis and adjustment of the operational parameters would occur during the design phase. Alternative 4 assumes

that the extraction wells would initially operate continuously, but that over time, the alternative would transition to MNA and existing phytoremediation. The MNA component of this alternative also consists of allowing the portions of the plume downgradient of the extraction wells to attenuate naturally. Based on modeling in the Revised FS Report, the RAOs would be met in approximately 20 years.

Site SS089 (1100 Area) Alternative 5 – Enhanced Bioremediation and Institutional Controls (Preferred Alternative). Alternative 5 includes enhanced bioremediation of the TCE in the saturated zone. Biological degradation of the TCE has already been observed in some groundwater samples from the site. A carbon substrate, such as LactOil[®], which is a mixture of ethyl lactate and emulsified vegetable oil, would be injected into the subsurface to promote biodegradation. The reduction of the residual TCE and any daughter products formed during the treatment progress would be monitored until the concentrations are less than the MCL. Potential by-products of the anaerobic treatment, such as dissolved gases and metals, also would be monitored. ICs would remain in place until the RAOs are achieved. The estimated time to reach RAOs is approximately 7 years.

2.8.2.3 Site SS090 (Golf Course Area) Remedial Alternatives

Seven remedial alternatives were presented in the Revised FS Report (CH2M HILL 2010a) for remediating PCE and TCE from groundwater and soil at Site SS090 (Golf Course Area). An additional alternative was included in the FS Supplement (EA 2014a). Table 2-12 summarizes the components of each remedy. Brief descriptions of each alternative include:

Site SS090 (Golf Course Area) Alternative 1 – No Action. Alternative 1 consists of taking no further action. This alternative serves as a baseline for evaluating alternatives and is required by the NCP. Under the No Action Alternative, the estimated remedial timeframe to achieve RAOs is approximately 75 years.

Site SS090 (Golf Course Area) Alternative 2 – Oil Shield, Monitored Natural Attenuation, and Institutional Controls. A layer of vegetable oil would be delivered to the water table to intercept PCE and TCE infiltration to the water table from the source zone. This is an innovative technology requiring several design assumptions. It was estimated that approximately 2,300 gallons of vegetable oil would be needed to form a barrier underlying the PCE and TCE areas above risk-based screening levels. The vegetable oil would be gravity fed through six permanent injection wells. The permanent well locations would also allow for periodic oil shield replenishment. This alternative also includes MNA, consisting of routine groundwater sampling. The estimated remedial timeframe is 75 years, which is the same as the No Action Alternative.

Site SS090 (Golf Course Area) Alternative 3 – Soil Vapor Extraction, Monitored Natural Attenuation, and Institutional Controls. Alternative 3 consists of installing soil vapor extraction (SVE) wells in the source area to remove PCE and TCE from soil, mitigating migration to groundwater. The initial implementation assumption was that five SVE wells would be placed in the source zone. The SVE system would operate until attainment of soil RGs. MNA would be the groundwater remedy, implementation of which is assumed the same as described for the MNA component of Alternative 2. The estimated remedial timeframe is approximately 39 years.

Site SS090 (Golf Course Area) Alternative 4 – Soil Vapor Extraction, In Situ Treatment, Monitored Natural Attenuation, and Institutional Controls. Alternative 4 is intended to remediate the source area using SVE and to accelerate remediation of the groundwater with in situ treatment. The SVE treatment assumptions are the same as described for Alternative 3. The in situ treatment was assumed to consist of annual delivery of the chemical oxidant sodium permanganate through eight injection wells. Assumptions include SVE of the source area and in situ treatment of the groundwater would be performed in parallel for approximately the first 5 years. Thereafter, the plumes would be left to degrade by natural

attenuation. Assumptions about the MNA component are the same as described for Alternative 2. The estimated remedial timeframe is approximately 31 years.

Site SS090 (Golf Course Area) Alternative 5 – Groundwater Extraction and Discharge, Monitored Natural Attenuation, and Institutional Controls. Alternative 5 consists of source control using groundwater extraction, MNA of the plumes, and ICs. A pump would be installed in the hot spot of groundwater contamination beneath the source area. Pumping would occur over the duration that PCE and TCE remain in the unsaturated zone above concentrations that sustain the groundwater plumes. Remediation of the plumes downgradient of the capture zone would be by MNA. The alternative would also transition to only MNA and ICs at the conclusion of the pumping period. The estimated remedial timeframe is approximately 75 years.

Site SS090 (Golf Course Area) Alternative 6 – Excavation, Monitored Natural Attenuation, and Institutional Controls. Alternative 6 consists of excavation and disposal of soil from the source area, thereby removing PCE and TCE contaminant mass and preventing further contaminant migration to the saturated zone. The groundwater plumes would attenuate by continued natural degradation processes and progress toward meeting RAOs would be monitored. Additionally, this alternative includes existing ICs to restrict groundwater use to limit potential future exposures. These controls would be implemented until RAOs are achieved. Excavation and disposal activities would be performed in less than 6 months. The estimated remedial timeframe is approximately 38 years.

Site SS090 (Golf Course Area) Alternative 7 – Soil Vapor Extraction, Phytoremediation, Monitored Natural Attenuation, and Institutional Controls. Alternative 7 consists of PCE and TCE SVE from soil in the source zone and phytoremediation near the downgradient portion of the PCE plume. The depth to groundwater in the target treatment area is approximately 30 ft bgs. Remediation of the plumes downgradient of the tree farm would be by MNA as described for Alternative 2. The rates of PCE and TCE uptake by trees were estimated and used to predict potential phytoremediation remedial timeframes; combined with SVE and natural attenuation, the estimated remedial timeframe is approximately 30 years.

Site SS090 (Golf Course Area) Alternative 8 – Limited Excavation, Enhanced Bioremediation, Monitored Natural Attenuation, and Institutional Controls (Preferred Alternative). Alternative 8 includes enhanced bioremediation of the PCE and TCE in the saturated and unsaturated zones. A portion of the contaminated soil in the unsaturated zone within the source area would be addressed by limited excavation; the excavated soil would be replaced by an uncontaminated carbon source and potentially other organic and/or inorganic additives. A groundwater recirculation system will pass contaminated groundwater from the source area over the backfill and the remaining deeper contaminated soil in the vadose zone. This will result in enhanced bioremediation of the residual contaminants in the soil and the groundwater in the source area. Details of the system would be determined during the design phase.

Additionally, a carbon substrate (emulsified vegetable oil) will be injected into rows of injection points (i.e., biobarriers) downgradient of the source area to reduce the PCE and TCE concentrations in groundwater. Enhanced bioremediation is an active treatment technology that will reduce contaminant concentrations within the treatment zone at this site more quickly than natural attenuation. The natural attenuation of the residual PCE and TCE contaminants outside of the treatment zone would be monitored until the concentrations are below the MCLs. ICs would remain in place until the RAOs are achieved. The estimated remedial timeframe is approximately 31 years.

2.8.2.4 Estimation Methods for Remedial Timeframes

The methods for determining the estimated time to achieve RAOs for each site include:

Site SS108 (800/900 Area). Concentrations of CT in the monitoring wells at this site are currently fluctuating around the MCL. The estimated time to reach RAOs was assumed to be 2 years, consisting of quarterly confirmation sampling.

Site SS089 (1100 Area). Alternative 5 involves in situ treatment applied in injection rows spread out over accessible areas of the plume. As outlined in the OU 9 FS Supplement (EA 2014a), the substrate proposed for the injections is expected to maintain reducing conditions for approximately 2 years. This period is assumed to be followed by 2 years of quarterly confirmation sampling. Using this methodology, the total period to achieve RAOs is 7 years.

Site SS090 (Golf Course Area). Alternative 8 provides in situ treatment in the same locations and zones (saturated and unsaturated) as Alternative 4. Therefore, the estimated remedial timeframe for Alternative 8 was assumed to be equivalent to that of Alternative 4, approximately 31 years.

2.8.3 Distinguishing Features and Expected Outcomes of Remedial Alternatives

This section presents distinguishing features of each alternative, including key ARARs associated with each site-specific alternative, estimated time for design and construction, estimated time to reach RAOs, the estimated capital costs, annual O&M costs, present worth costs, and the expected outcome of each alternative. This information is summarized in Tables 2-13 through 2-15. The sources of the estimated remedial timeframes and costs are the OU 9 Revised FS Report (CH2M HILL 2010a) and the OU 9 FS Supplement (EA 2014a).

As shown in Tables 2-13 through 2-15, key ARARs vary from alternative to alternative. The relative performance of each alternative is described in detail in Section 2.9, which includes a comparative analysis of each alternative against the nine NCP criteria. As shown in Tables 2-13 through 2-15, aside from varying ARARs, the key distinguishing features between each of the alternatives of each site are the capital and total present worth costs. In addition, there is a significant difference in the remedial timeframe between the various alternatives evaluated for each site.

2.9 Summary of Comparative Analysis of Alternatives

2.9.1 Summary of Evaluation Criteria

This comparative analysis evaluates relative performance of the OU 9 site-specific remedial alternatives with respect to the nine evaluation criteria described in Section 121(b) of CERCLA and the NCP Section 300.430(f)(5)(i). These criteria are classified as threshold criteria, balancing criteria, and modifying criteria. A summary of the comparative analysis of alternatives based on threshold and balancing criteria is presented in Tables 2-16 through 2-18.

Threshold criteria are standards that an alternative must meet to be eligible for selection as a remedial action. There is little flexibility in meeting the threshold criteria – the alternative must meet them or it is unacceptable. The following are classified as threshold criteria:

- Overall protection of human health and the environment
- Compliance with ARARs or justification of a waiver.

Balancing criteria weigh the tradeoffs between alternatives. These criteria represent the standards upon which the detailed evaluation and comparative analysis of alternatives are based. In general, a high rating on one criterion can offset a low rating on another balancing criterion. Five of the nine criteria are considered balancing criteria:

- Long-term effectiveness and permanence
- Reduction of TMV through treatment
- Short-term effectiveness
- Implementability
- Cost.

Modifying criteria includes:

- Community acceptance
- State/support agency acceptance.

This section summarizes how well each alternative satisfies each evaluation criterion and indicates how it compares to the other alternatives under consideration. An overview of the criteria evaluation is presented in Tables 2-16 through 2-18 for Sites SS108 (800/900 Area), SS089 (1100 Area), and SS090 (Golf Course Area), respectively.

2.9.2 Comparative Analysis of the Alternatives

Based on the individual evaluation and assessment of each site-specific remedial alternative, a comparative analysis (EA 2014a) is presented in this section to evaluate the relative performance of each alternative in relation to each of the nine specific evaluation criteria. The comparative analysis identifies the advantages and disadvantages of each alternative relative to the others.

2.9.2.1 Overall Protection of Human Health and the Environment (Protectiveness)

Site SS108 (800/900 Area). Of the two alternatives, only Alternative 2 is protective of human health and the environment. Alternative 1 is not protective of human health and the environment due to the lack of groundwater monitoring, the potential for unknown exposure, and discontinued enforcement of ICs. Without the collection of data, achieving RAOs would not be demonstrated. Alternative 2 is protective of human health and the environment because it includes ICs in the form of groundwater use restrictions that minimize exposure and continue monitoring to determine the concentration of contaminants in groundwater.

Site SS089 (1100 Area). All of the alternatives, except Alternative 1, are protective of human health and the environment by including ICs in the form of groundwater use restrictions that minimize exposure and continue monitoring to determine the concentration of contaminants in groundwater. Alternative 1 is not protective of human health and the environment because of the lack of groundwater monitoring, the potential for unknown exposure, and discontinued enforcement of ICs. Since Alternative 5 would attain cleanup goals before the other alternatives, it would be more protective of human health and the environment.

Site SS090 (Golf Course Area). All of the alternatives, except Alternative 1, are protective of human health and the environment. Since the plumes are considered stable, Alternatives 2 through 8 achieve RAOs 1, 2, and 3. The source control components of Alternatives 2 through 8 achieve RAO 4. Alternative 1 is not protective of human health and the environment because of the lack of groundwater monitoring, the potential for unknown exposure, and discontinued enforcement of ICs. Since Alternatives 4, 7, and 8 would attain cleanup goals in a shorter timeframe than the other alternatives, Alternatives 4, 7, and 8 would be more protective of human health and the environment.

2.9.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

Site SS108 (800/900 Area). Of the two alternatives, only Alternative 2 is compliant with ARARs. Alternative 2 complies with location-, action-, and chemical-specific ARARs as aquifer restoration will be achieved in a reasonable timeframe and restrictions to groundwater use are in place. Alternative 1 does not comply with ARARs because groundwater monitoring would not be conducted to ensure that groundwater quality regulations that require groundwater restoration are achieved. Because Alternative 1 does not meet the threshold criteria, it was not evaluated further.

Site SS089 (1100 Area). All of the alternatives, except Alternative 1, are compliant with ARARs. Alternatives 2 through 5 comply with location-, action-, and chemical-specific ARARs because aquifer restoration will be achieved in a reasonable timeframe, restrictions to groundwater use are in place, and discharge of extracted groundwater or injection of substrates or reactants would comply with federal and state standards. Alternative 1 does not comply with ARARs because groundwater monitoring would not be conducted to ensure that groundwater quality regulations requiring groundwater restoration are achieved. Because Alternative 1 does not meet the threshold criteria, it was not evaluated further. The estimated remedial timeframe for Alternatives 2 through 4 ranges from approximately 20 to 24 years. The estimated remedial timeframe for Alternative 5 is shorter at approximately 7 years.

Site SS090 (Golf Course Area). All of the alternatives, except Alternative 1, comply with location-, action-, and chemical-specific ARARs. Aquifer restoration will be achieved in a reasonable timeframe, restrictions to groundwater use are in place, and injection of treatment chemicals, discharge of extracted groundwater, or groundwater recirculation would occur in compliance with federal and state standards. Alternative 1 does not comply with ARARs because groundwater monitoring would not be conducted to ensure that groundwater quality regulations requiring groundwater restoration are achieved. Because Alternative 1 does not meet the threshold criteria, it was not evaluated further. The estimated remedial timeframe for Alternatives 2 and 5 is longest at approximately 75 years. The estimated remedial timeframe for Alternatives 3, 4, 6, 7, and 8 ranges from approximately 30 to 39 years.

2.9.2.3 Long-Term Effectiveness and Permanence

Site SS108 (800/900 Area). Alternative 2 has good long-term effectiveness because it has the potential to achieve the RAOs without residual risks.

Site SS089 (1100 Area). Alternatives 2 through 5 have good long-term effectiveness because they have the potential to achieve the RAOs without residual risks. Additionally, all considered alternatives have an active treatment or MNA component, which is predicted to remediate the TCE within a reasonable timeframe. The in situ treatment associated with Alternative 5 may result in the generation of by-products and may mobilize some metals by changing the subsurface conditions, but these effects are expected to be localized and temporary. The LactOil substrate used at this site is expected to produce reducing conditions in the injection zones for approximately 2 years. The by-products of the anaerobic conditions produced by the in situ treatment, such as mobilized metals, methane, and the daughter

products generated due to reductive dechlorination are expected to attenuate relatively quickly under aerobic conditions after the substrate expires.

Site SS090 (Golf Course Area). Alternatives 2 through 8 are expected to remediate the plumes permanently without creating residual risks. Alternatives 2 and 8 would be expected to result in reductive dechlorination, which can cause buildup of daughter products; however, the generation of daughter products is expected to be localized to the treatment area. Away from the treatment areas, naturally occurring aerobic conditions are expected to predominate. The daughter products of the reductive dechlorination of the chlorinated solvents are expected to rapidly attenuate under aerobic conditions. For Alternatives 3, 4, and 7, SVE permanently removes mass from the source zone. The in situ treatment associated with Alternatives 4 and 8 may mobilize some metals by changing the aquifer redox conditions.

For the anaerobic treatment in Alternative 8, an emulsified vegetable oil substrate will be selected to maintain reducing conditions within the injection zones for several years after each injection. Because the pretreatment aquifer conditions are aerobic (CH2M HILL 2010a), concentrations of the by-products of anaerobic conditions (e.g., mobilized metals, and methane) are expected to return to approximately pretreatment levels after reducing conditions no longer persist following the treatment period. The mass removal of Alternatives 3, 4, 5, 6, 7, and 8 is believed to be effective in the long term.

2.9.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Site SS108 (800/900 Area). Alternative 2 relies on natural attenuation mechanisms to reduce toxicity of contaminants and does not include active treatment. However, through monitoring, this alternative would show that a reduction in TMV is achieved. Due to the lack of active treatment, Alternative 2 was given a fair rating for reduction of TMV.

Site SS089 (1100 Area). Alternatives 2 through 5 actively reduce TMV. Therefore, these alternatives have good rankings for reduction of TMV. However, as Alternative 5 includes a more aggressive form of treatment (enhanced bioremediation) than Alternatives 2 through 4, which provide treatment via a more passive method (phytoremediation), Alternative 5 is preferred.

Site SS090 (Golf Course Area). It is estimated that more contaminant mass is adsorbed in the source zone soil than exists in any other media. Therefore, the primary differentiator in TMV reduction among the alternatives is the degree to which each alternative treats the source zone. Alternatives 3, 4, 6, 7, and 8 have the greatest reduction in TMV because they involve direct removal of mass from the source zone. Alternative 8 has an added benefit as the bioreactor will treat both soil and groundwater below the bioreactor in the source area, and groundwater will be treated in the area downgradient of the source through injection of a carbon substrate. Alternatives 2 and 5 do not directly treat the contaminants in the source zone. Therefore, Alternatives 2 and 5 received a fair ranking for TMV reduction. Although Alternatives 3 and 8 received similar rankings for the reduction of TMV through treatment, Alternative 3 does not actively treat groundwater contaminants, so Alternative 8 provides a higher degree of treatment than Alternative 3.

2.9.2.5 Short-Term Effectiveness

Site SS108 (800/900 Area). Alternative 2 presents minimal short-term risk to the community or workers and achieves the RAOs in a relatively short timeframe.

Site SS089 (1100 Area). Implementation of Alternatives 2 through 4 would present manageable health and safety risks associated with O&M to the community or workers. Alternatives 4 and 5 present some potential, but unlikely, short-term risks to workers while implementing the remedy. These risks can be

mitigated by following standard health and safety practices and proper construction safety measures and by implementing appropriate traffic plans. Alternative 5 achieves RAOs in a much shorter timeframe than the other remedial alternatives, which improves its ranking for short-term effectiveness. Alternative 4 would require long-term O&M and, as a result, received a fair ranking.

Site SS090 (Golf Course Area). Alternatives 2 through 8 present some potential, but unlikely, short-term risks to workers while implementing the remedy. These risks can be mitigated by following standard health and safety practices and proper construction safety measures and by implementing appropriate traffic plans. Alternatives 3, 4, 6, 7 and 8 that treat or remove the source area achieve RAOs within the shorter timeframe of 30 to 40 years. Alternatives 2 and 5 either do not address the source area or strictly contain the source area and are estimated to take approximately twice as long to reach RAOs, thus reducing their short-term effectiveness rankings. Alternatives 2, 3, and 7 require less energy to implement and operate compared to Alternatives 4, 5, 6, and 8.

2.9.2.6 Implementability

Site SS108 (800/900 Area). Alternative 2 is easily implemented, both technically and administratively.

Site SS089 (1100 Area). All alternatives are implementable. Alternative 2 is easily implemented, both technically and administratively. Alternative 3 should be easily implemented if no security or administrative concerns are involved with planting trees along the Base boundary. Alternative 4 may be more difficult to implement than the other alternatives because construction would occur between the Base boundary and Main Street in Sunset City. Implementing Alternative 5 requires injection of a substrate or reactant into the saturated zone. Based on results of a treatability study, injecting substrate at this site is feasible using a lower injection rate than what may be possible in an area with more permeable material (EA 2014d).

Site SS090 (Golf Course Area). All alternatives are easily implemented except Alternative 5. Although Alternative 5 is implementable, it would require extensive trenching and construction of the discharge pipeline necessary as part of the groundwater extraction system. As a result, Alternative 5 received a fair rating for implementability.

2.9.2.7 Cost

Detailed cost estimates for the remedial alternatives of each site are presented in the Revised FS Report (CH2M HILL 2010a) or FS Supplement (EA 2014a). Cost estimates are based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur because of new information and data collected during the engineering design of the remedial alternatives. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD Amendment. These estimates are order-of-magnitude engineering cost estimates that are expected to be within +50 to -30 percent of the actual project cost. The present worth of each alternative was calculated using the real discount rates in the White House Office of Management and Budget Circular A-94 (http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c/). This is consistent with the guidance for federal facilities in the EPA guidance document A Guide to Preparing and Documenting Cost Estimates during the FS (EPA 2000). The cost estimates are presented in the OU 9 Revised FS Report (CH2M HILL 2010a) and the OU 9 FS Supplement (EA 2014a). A summary is presented in this subsection.

Site SS108 (800/900 Area). The estimated present worth cost of Alternative 2 is \$0.12 million, with most of the cost associated with groundwater monitoring (Table 2-13).

Site SS089 (1100 Area). As shown in Table 2-14, of the considered alternatives, the cost associated with Alternative 2 is lowest, at approximately \$1.1 million. The costs of Alternatives 3 and 5 are in the intermediate range, at \$2.1 to \$2.2 million, respectively. The estimated cost of Alternative 4 is highest, at approximately \$4.4 million. Alternatives 3 and 4 are not cost effective given the negligible predicted reduction in remedial timeframe. For an intermediate cost, Alternative 5 is predicted to have by far the shortest restoration timeframe.

Site SS090 (Golf Course Area). As shown in Table 2-15, of the considered alternatives, the estimated costs of Alternatives 2, 3, and 8 are the lowest, ranging from approximately \$1.8 million to \$2.4 million. The estimated cost for Alternative 7 is in the intermediate range at \$3.3 million. The estimated costs of Alternatives 4, 5, and 6 are the highest, ranging from \$5.2 million to \$8.2 million. For roughly the same cost as Alternatives 2 and 3, Alternative 8 is predicted to have a significantly shorter restoration timeframe than Alternative 2 and a slightly shorter restoration timeframe than Alternative 3.

2.9.2.8 State/Support Agency Acceptance

The EPA approves and UDEQ concurs with the selected remedies:

- Site SS108 (800/900 Area) – Alternative 2 (MNA with ICs)
- Site SS089 (1100 Area) – Alternative 5 (Enhanced Bioremediation and ICs)
- Site SS090 (Golf Course Area) – Alternative 8 (Limited Excavation, Enhanced Bioremediation, MNA, and ICs).

2.9.2.9 Community Acceptance

Public comment on the Proposed Plan for OU 9 was solicited to evaluate community acceptance of the preferred alternatives. The public meeting was held on 8 October 2014 in Sunset City, Utah. The public comment period was held from 1 October 2014 to 31 October 2014. During the public comment period, no comments were received. A sign-in sheet with the names of those in attendance at the public meeting is included in Appendix A.

2.10 Principal Threat Wastes

The NCP expects that treatment that reduces the TMV of the principal threat wastes will be used to the extent practicable. The principal threat concept refers to the source materials at a CERCLA site considered highly toxic or highly mobile that generally cannot be reliably controlled in place or present a significant risk to human health or the environment should exposure occur (EPA 1999a). This definition typically applies to liquid wastes or soil containing significant concentrations of highly toxic materials. There are no principal threat wastes present at the OU 9 sites. Although the PCE and TCE concentrations in soil within the source area at Site SS090 (Golf Course Area) represents a source of ongoing low-level contamination to groundwater, these soil concentrations do not exceed residential risk-based screening levels. As a result, the source area soil at Site SS090 (Golf Course Area) does not represent a principal threat waste. Similarly, no remaining sources or principal threat wastes are present at Sites SS108 (800/900 Area) or SS089 (1100 Area).

2.11 Selected Remedy

The primary indicator of remedial action performance will be satisfying the RAOs for OU 9 and protecting human health and the environment. Performance measures are defined herein as the RAOs (Section 2.7) and the required actions to achieve the objectives, as defined in this section. It is anticipated that successful implementation, O&M, and completion of the performance measures will achieve a protective and legally compliant remedy for OU 9.

The remedies for OU 9 were selected based upon the belief that they satisfy threshold criteria and provide the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. This section describes the selected remedies for the various areas within OU 9.

Remedy selections are based on the detailed evaluation of remedial alternatives presented in the Revised FS Report (CH2M HILL 2010a), FS Supplement (EA 2014a), and the Proposed Plan (EA 2014c). These remedies will remain in effect and be protective of human health and the environment until the concentrations of COCs decrease to below applicable RGs.

The USAF is responsible for implementing, maintaining, and monitoring the remedial actions selected in this ROD. The USAF will exercise this responsibility in accordance with CERCLA and the NCP. Approval by the EPA and concurrence by the UDEQ is required for any modification of the remedy inconsistent with the objectives of this ROD.

2.11.1 Institutional Controls

ICs are used when contamination remains onsite at a level that does not allow for UU/UE. ICs are required for OU 9 due to the presence of groundwater and soil contaminants above RGs. The USAF is responsible for implementing, monitoring, maintaining, reporting on, and enforcing the ICs, including specific actions as described in the Base General Plan and the Restricted Areas Use Map. The USAF also is obligated to inform, monitor, enforce, and bind, where appropriate, authorized lessees, tenants, contractors, and other authorized occupants of the site of the ICs impacting OU 9. Where state agencies bear a significant enforcement role, the USAF will maintain regular communication with the state agencies and request appropriate notification of enforcement actions. If the USAF and EPA determine that specific IC requirements are not being met, it is understood that the remedy may be reconsidered and additional measures may be required to protect human health and the environment. The USAF will maintain ultimate responsibility for remedy integrity.

ICs are not needed to restrict soil exposure because soil concentrations are below residential screening levels. An evaluation of soil gas data indicates risks to a hypothetical future resident are within the low end of the acceptable risk range. ICs are needed only to control potential risks from use of groundwater.

ICs are a component of each of the selected remedies for the three OU 9 sites. The objective of these ICs is to prevent access or use of shallow groundwater until cleanup levels are met. Because Hill AFB is expected to remain under the jurisdiction of the Department of Defense for the foreseeable future, the future on-Base land use for OU 9 is expected to be industrial and/or commercial. The ICs selected to protect human health and the environment have taken these potential future land use scenarios into account and include the following objectives:

- Prevent access or use of shallow groundwater until cleanup levels are met
- Maintain the integrity of any current or future remedial or monitoring systems

- Review construction projects potentially impacting contaminated groundwater.

ICs prohibiting use of shallow groundwater within OU 9 have been enacted to prevent exposure until contaminants are at concentrations that allow for UU/UE. The extent of ICs associated with the OU 9 sites is shown in Figure B-2 in Appendix B. These restrictions will remain in place and be monitored for effectiveness until contaminant concentrations in groundwater are at levels that allow for UU/UE. Specific land use prohibitions are not necessary for OU 9 based on the risk assessment conclusions.

The off-Base ICs will include the following measure:

- Utah DWRi restrictions on the installation of new wells in the shallow aquifer in off-Base areas will be maintained as described in the Utah DWRi documentation. State water rights and well drilling restrictions will be maintained to prevent human exposure to off-Base groundwater from the shallow aquifer containing COC concentrations above the MCL. The Utah DWRi regulates appropriation and distribution of all water within the State of Utah and has developed a groundwater management plan entitled, Ground-Water Management Plan for the Weber Delta Sub-Area of the East Shore Area (Utah DWRi 1995), which includes the off-Base areas of groundwater contamination associated with Hill AFB. This plan does not permit installation of wells in the off-Base areas of the shallow aquifer in areas of groundwater contamination associated with OU 9 (and other Hill AFB OUs). The USAF will send a letter to the Utah DWRi annually requesting verification of continuing enforcement of these restrictions throughout the life of the remedy, though the USAF will ultimately be responsible for maintaining the integrity of the remedy.

The internal procedures that Hill AFB will use to implement ICs include but are not limited to the following:

- The USAF will update and distribute to Base organizations a Restricted Areas Use Map identifying areas where construction or other activities that will disturb the soil or groundwater, or that will interfere with remedial action equipment or facilities cannot occur without prior concurrence from Environmental Restoration (Air Force Civil Engineer Center [AFCEC]/CZOM Hill Section). This information is incorporated into the Base General Plan. The USAF will enter the ICs into the Restricted Areas Use Map for Hill AFB within 30 days after the ROD signature.
- Monitoring of ICs will be conducted annually by the USAF. Monitoring results will be included in a separate report or as a section of another environmental report, if appropriate, and provided to the EPA and UDEQ. The annual monitoring reports will be used in preparation of the Five-Year Review to evaluate the effectiveness of the remedy. The annual monitoring reports, submitted to the regulatory agencies by the USAF, will evaluate the status of ICs and how any IC deficiencies or inconsistent uses have been addressed. The annual evaluation will address whether the ICs referenced above were communicated in deed(s), whether the owners and state and local agencies were notified of the ICs affecting the property, and whether use of the property has conformed to such restrictions and controls.
- Environmental Restoration (AFCEC/CZOM Hill Section) will review construction proposals (Air Force Form 332) and Environmental Impact Analysis forms (Air Force Form 813) to ensure that the proposed projects comply with ICs and do not interfere with their effectiveness.

The USAF will notify EPA and UDEQ in advance of any changes to internal procedures associated with the selected remedies that might affect the ICs.

2.11.1.1 Breaches of Institutional Controls

Any activity that is inconsistent with the IC objectives or use restrictions, or any other action that may interfere with the effectiveness of the ICs will be addressed by the USAF as soon as practicable, but in no case will the process be initiated later than 10 days after the USAF becomes aware of the breach. The USAF will notify the EPA and UDEQ as soon as practicable, but no longer than 10 days after discovery, of any activity that is inconsistent with the IC objectives or use restrictions, or any other action that may interfere with the effectiveness of the ICs. The USAF will notify the EPA and UDEQ regarding how the USAF has addressed or will address the breach within 10 days of sending EPA and UDEQ notification of the breach.

2.11.1.2 Land Use Changes and Transfers

The USAF will notify the EPA and UDEQ at least 6 months before any transfer or sale of OU 9 property containing ICs so that the EPA and UDEQ can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for the USAF to notify the EPA and UDEQ at least 6 months before any transfer or sale, then the USAF will notify the EPA and UDEQ as soon as possible but no later than 60 days before the transfer or sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions above, the USAF further agrees to provide the EPA and UDEQ with such notice within the same timeframes, for federal-to-federal transfer of property accountability. In the case of federal transfers, there is no deed transfer as the property continues to be owned by the U.S. Government. However, a transfer assembly document is used to transfer the property from one federal agency to another. The USAF will provide a copy of the transfer assembly (or in the unlikely event of a transfer to a non-federal transferee, an executed deed) to the EPA and UDEQ.

The USAF will notify the EPA and UDEQ 45 days in advance of any proposed land use changes that are inconsistent with IC objectives or the selected remedy.

2.11.1.3 Modification or Termination

The USAF shall not modify or terminate ICs, implementation actions, or land use that are associated with the selected remedy without the approval of EPA and the opportunity for concurrence by UDEQ. The USAF shall seek prior concurrence of EPA and UDEQ before any anticipated action that may disrupt the effectiveness of the ICs or any action that may alter or negate the need for ICs.

2.11.1.4 Responsible Party for Implementation

The USAF is responsible for implementing, monitoring, maintaining, reporting on, and enforcing the ICs, including specific actions described in the Base General Plan and the Restricted Areas Use Map. The USAF also is obligated to inform, monitor, enforce, and bind, where appropriate, authorized lessees, tenants, contractors, and other authorized occupants of the site of the ICs impacting OU 9. If the USAF and EPA determine that specific IC requirements are not being met, it is understood that the remedy may be reconsidered and that additional measures may be required to protect human health and the environment.

Although the USAF may later transfer procedural responsibilities to another party by contract, property transfer agreement, or through other means, the USAF shall retain ultimate responsibility for remedy integrity.

2.11.2 Site SS108 (800/900 Area)

2.11.2.1 Summary of the Rationale for the Selected Remedies

The selected remedial alternative for Site SS108 (800/900 Area) is Alternative 2 – MNA and ICs. The USAF believes that the selected remedy meets the threshold criteria and provides a good balance of tradeoffs with respect to the balancing and modifying criteria. The remedies are expected to satisfy the statutory requirements of CERCLA Section 121(b) (Section 2.12).

Alternative 2 meets threshold criteria because it includes ICs in the form of groundwater use restrictions, groundwater monitoring, and aquifer restoration in a reasonable timeframe. Also, it represents a good balance with respect to the five balancing criteria. The selected remedy demonstrates long-term effectiveness because the concentration of CT is already fluctuating around the MCL at all remaining monitoring wells at the site. MNA will be conducted to verify that concentrations remain below the MCL. The selected remedy has been approved by the EPA with concurrence by the UDEQ, and it is easily implemented, presents minimal short-term risk to the community or workers, and achieves the RAOs in a relatively short timeframe.

2.11.2.2 Description of the Selected Remedy

The selected remedy for Site SS108 (800/900 Area) consists of maintaining ICs in place while monitoring the groundwater to confirm that the concentration of CT remains below the MCL to support site closeout. The RAOs will be met following the collection of MNA data at groundwater Monitoring Well U9-014 (Figure 2-2), indicating that the concentration of CT in groundwater remains below the MCL.

Monitored Natural Attenuation. MNA consists of RA-O performance monitoring of the CT groundwater plume to verify that concentrations remain below the MCL. The performance monitoring includes the collection of groundwater samples for analysis of VOC concentrations. Plume stability implies that construction of additional monitoring wells will be unnecessary. The VOC parameters will support assessments of the CT concentration trend.

Institutional Controls. ICs are the same for the selected remedies for each of the three OU 9 sites and are described in Section 2.11.1.

2.11.2.3 Summary of Estimated Remedy Costs

The estimated cost (present worth) of the selected remedy for Site SS108 (800/900 Area) is approximately \$0.12 million, with the majority of the cost associated with groundwater monitoring. A summary of the cost estimate is provided in Appendix C. The cost estimate is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as new information and data are collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD Amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

2.11.2.4 Expected Outcomes of Selected Remedy

It is anticipated that the relevant RAOs will be achieved in approximately 2 years from the implementation of the selected remedy. Concentrations of CT at the site are already fluctuating around the MCL; however, MNA is necessary to verify that concentrations remain below the MCL. Upon

confirmation that RGs (Table 2-2) have been attained, the site will be closed. After closeout, the site will be available for UU/UE land use. ICs will no longer be required because of attainment of the RGs.

2.11.3 Site SS089 (1100 Area)

2.11.3.1 Summary of the Rationale for the Selected Remedies

The selected remedial alternative for Site SS089 (1100 Area) is Alternative 5 – Enhanced Bioremediation and ICs. The USAF believes the selected remedy meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. The remedies are expected to satisfy the statutory requirements of CERCLA Section 121(b) (Section 2.12).

Alternative 5 meets threshold criteria because it provides ICs in the form of groundwater use restrictions, includes groundwater monitoring, will accomplish aquifer restoration in a reasonable timeframe, and will comply with federal and state standards. In addition, it represents the best balance of the five balancing criteria. The selected remedy demonstrates long-term effectiveness and TMV reduction as the concentration of TCE in groundwater will be reduced to the RG and RAOs will be achieved. The remedy is implementable and presents a short-term risk to the community or workers, which can be managed by following standard health and safety procedures, proper construction safety measures, and by implementing appropriate traffic plans. The selected remedy is anticipated to achieve RAOs in less time than the other alternatives with an intermediate cost relative to the other alternatives. The selected remedy has been approved by the EPA with concurrence by the UDEQ.

2.11.3.2 Description of the Selected Remedy

The selected remedy includes enhanced bioremediation and prevention of exposure to contaminated media by the continued implementation of ICs, both on- and off-Base. Figure 2-8 shows the approximate locations of enhanced bioremediation implementation. The remedy may change somewhat during remedial design and construction. Major changes to the remedy as described in this ROD, if they occur, will be documented using a technical memorandum in the Administrative Record, an ESD, or ROD Amendment.

Enhanced Bioremediation. This component consists of enhanced bioremediation of the TCE in the saturated zone. Biological degradation of TCE has already been observed in some groundwater samples from the site. A carbon substrate, such as *LactOil*, which is a mixture of ethyl lactate and emulsified vegetable oil, will be injected into the subsurface to provide substrate for the native microorganisms to degrade TCE. The USAF initiated a full-scale treatability study at the site in 2014 to test this approach (EA 2014b). Reduction of the residual TCE and any daughter products formed during the treatment progress will be monitored until the concentrations are less than the MCL. Potential by-products of the anaerobic treatment, such as dissolved gases and metals, also will be monitored. ICs will remain in place until the RAOs are achieved. The estimated time to reach RAOs is approximately 7 years.

The primary uncertainties with this alternative are (1) the potential need for bioaugmentation, (2) the effective distribution of substrate in the subsurface, (3) the extent of contact with the TCE for treatment, and (4) the potential generation of by-products resulting from enhanced reductive dechlorination treatment. The recent bench-scale test for enhanced bioremediation at OU 10 indicated that bioaugmentation was needed to create significant reductions in PCE and TCE concentrations in laboratory microcosms. However, the 2007 pilot-scale test of enhanced bioremediation at OU 10 demonstrated significant reduction of TCE to cis-1,2-DCE without bioaugmentation. Additionally, TCE

concentrations historically observed in monitoring wells at Site SS089 (1100 Area) are less than those at the OU 10 pilot study site. For these reasons, bioaugmentation is not initially proposed as part of Alternative 5, but will be added, if needed, to meet RAOs, based on performance monitoring data. To address the uncertainties regarding substrate distribution and contact with contaminants, an additional injection event may be needed to apply additional substrate at different dosing rates at newly selected injection locations to increase distribution of the substrate in the subsurface. To address the potential generation of by-products resulting from treatment, a relatively short-lived substrate (estimated at 2 years [JRW Bioremediation 2013]) will be used to allow for the reducing conditions created during the treatment period to return to pretreatment conditions. The remedial timeframe presented above accounts for treatment time and additional time for by-product concentrations to return to pretreatment concentrations.

Institutional Controls. ICs are the same for the selected remedies for each of the three OU 9 sites and are described in Section 2.11.1.

2.11.3.3 Summary of Estimated Remedy Costs

The estimated cost (present worth) of the selected remedy for Site SS089 is approximately \$2.2 million. A summary of the cost estimate is provided in Appendix C. The cost estimate is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as new information and data are collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD Amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

2.11.3.4 Expected Outcomes of Selected Remedy

It is anticipated that the relevant RAOs will be achieved within 7 years from the implementation of the selected remedy. Concentrations of TCE will be reduced below the RG (Table 2-2). Upon confirmation that the RG has been attained, the site will be closed. After closeout, the site will be available for UU/UE land use. ICs will no longer be required because of attainment of the RG.

2.11.4 Site SS090 (Golf Course Area)

2.11.4.1 Summary of the Rationale for the Selected Remedies

The selected remedial alternative for Site SS090 (Golf Course Area) is Alternative 8 – Limited Excavation, Enhanced Bioremediation, MNA, and ICs. The USAF believes that the selected remedy meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. The remedies are expected to satisfy the statutory requirements of CERCLA Section 121(b) (Section 2.12).

Alternative 8 meets threshold criteria because it provides ICs in the form of groundwater use restrictions, includes groundwater monitoring and source control, will accomplish aquifer restoration in a reasonable timeframe, and will comply with federal and state standards. In addition, it represents the best balance of the five balancing criteria. The selected remedy demonstrates good long-term effectiveness and TMV reduction because the concentration of PCE in soil and PCE and TCE concentrations in groundwater will be reduced to RGs and RAOs will be achieved. The remedy is implementable and presents a short-term risk to workers, which can be managed by following standard health and safety procedures, proper construction safety measures, and by implementing appropriate traffic plans. The selected remedy is

anticipated to achieve RAOs with a remedial timeframe that is similar to or shorter than the other alternatives and at a similar or lesser cost. The only less expensive alternative is the oil shield/MNA alternative (Alternative 2), which would take decades longer to complete. The selected remedy has been approved by the EPA with concurrence by the UDEQ.

2.11.4.2 Description of the Selected Remedy

The selected remedy for Site SS090 (Golf Course Area) consists of limited excavation, enhanced bioremediation of PCE and TCE in the saturated and unsaturated zones (Figure 2-9), MNA, and continued implementation of ICs to prevent exposure during remediation. The remedy may change somewhat during remedial design and construction. Major changes to the remedy as described in this ROD, if they occur, will be documented using a technical memorandum in the Administrative Record, an ESD, or ROD Amendment.

Enhanced Bioremediation – Bioreactor. A primary objective of the enhanced bioremediation component is to remediate the soil of the source zone, mitigating migration of PCE and TCE to groundwater. A portion of the contaminated soil in the unsaturated zone within the source area will be addressed by limited excavation; the excavated soil will be replaced by an uncontaminated carbon source and potentially other organic and/or inorganic additives. Excavated soil will be stockpiled, characterized, and disposed at a licensed disposal facility. A groundwater recirculation system will pass groundwater from the source area over the backfill for treatment and to aid in the distribution of carbon to the deeper contaminated soil in the vadose zone. This will result in enhanced bioremediation of the residual contaminants in the soil and the groundwater in the source area. As necessary, bioaugmentation of treatment zones will occur through the addition of naturally occurring bacteria that are known to degrade the site contaminants completely. Details of the system will be determined during the design phase.

Enhanced Bioremediation – Biobarrier. The treatment is anticipated to include the injection of a carbon substrate (possibly emulsified vegetable oil) into rows of injection points to reduce the PCE and TCE concentrations in groundwater downgradient of the source area. As necessary, bioaugmentation of treatment zones will occur through the addition of naturally occurring bacteria that are known to degrade the site contaminants completely. After completion of in situ treatment, the remedy will transition to MNA and ICs.

The primary uncertainties associated with this alternative are the effective distribution of injected substrate in the subsurface, the extent of contact with the PCE and TCE for treatment, and the potential generation of daughter products resulting from enhanced reductive dechlorination treatment. To address these uncertainties, an additional injection event may be necessary to apply additional substrate at different dosing rates in previous injection locations or at newly selected injection locations to increase distribution of the substrate in the subsurface. Bioaugmentation may be implemented to minimize potential daughter product formation.

Monitored Natural Attenuation. The natural attenuation of residual PCE and TCE contaminants outside of the treatment zones will be monitored until the concentrations are less than the MCLs.

The potential for natural attenuation of PCE and TCE in groundwater under natural (aerobic) geochemical conditions at this site has already been demonstrated (Section 1.6.3 of CH2M HILL 2010a). The natural attenuation of residual PCE and TCE contaminants outside of the anaerobic treatment zones will be monitored until the concentrations are below the MCLs. A relatively small transition zone is expected between the anaerobic treatment zones and the aerobic MNA areas, where a mixture of geochemical conditions and treatment mechanisms may occur. The geochemical conditions within the bulk of the plume area are expected to remain unchanged, and the rate of natural attenuation of the groundwater

contaminants within these areas is expected to remain unchanged from the estimates provided in the Revised FS Report (CH2M HILL 2010a).

The implementation of MNA outside of the treatment zones is consistent with the EPA OSWER guidance regarding MNA and will be consistent with the EPA OSWER tiers of evidence approach for the demonstration of natural attenuation (EPA 1999b). The newly constructed wells, as well as the current monitoring well network, will provide for long-term and performance monitoring. Data collection will continue until PCE and TCE concentrations decrease to below the RG (5-µg/L MCL). VOC data will be used to evaluate plume dynamics.

Institutional Controls. ICs are the same for the selected remedies for each of the three OU 9 sites and are described in Section 2.11.1.

2.11.4.3 Summary of Estimated Remedy Costs

The estimated cost (present worth) of the selected remedy for Site SS090 (Golf Course Area) is approximately \$2.4 million. A summary of the cost estimate is provided in Appendix C. The cost estimate is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur because of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD Amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

2.11.4.4 Expected Outcomes of Selected Remedy

It is anticipated that the RAOs will be achieved within approximately 30 years from the implementation of the selected remedy. Concentrations of TCE and PCE in groundwater and soil will be reduced below the applicable RGs (Tables 2-8 and 2-9). Upon confirmation that RGs have been attained, the site will be closed. After closeout, the site will be available for unrestricted land use. ICs will no longer be required because of attainment of the RGs.

2.12 Statutory Determinations

Under CERCLA Section 121 (as required by NCP Section 300.430[f][5][ii]), the lead agency must select a remedy that is protective of human health and the environment, complies with ARARs, is cost effective, and uses permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes:

- A preference for remedies that employ treatment that permanently and significantly reduces the TMV of hazardous wastes as a principal element
- A bias against offsite disposal of untreated wastes.

The following sections discuss how the selected remedy meets these statutory requirements.

2.12.1 Protection of Human Health and the Environment

2.12.1.1 Site SS108 (800/900 Area)

The selected remedy (Alternative 2 – MNA and ICs) is protective of human health and the environment. The selected remedy incorporates monitoring the groundwater to verify that the concentration of CT remains below the protective MCL of 5 µg/L to support site closeout. ICs in the form of groundwater use restrictions will remain in place until RAOs are achieved, preventing human exposure. The selected remedy does not disturb the contaminated media; therefore, implementation of the selected remedy will not pose unacceptable short-term risks nor will the selected remedy lead to cross-media impacts.

2.12.1.2 Site SS089 (1100 Area)

The selected remedy (Alternative 5 – Enhanced Bioremediation and ICs) is protective of human health and the environment. Enhanced bioremediation will reduce TCE concentrations to the protective MCL of 5 µg/L in a reasonable timeframe. Treatment of TCE will be monitored until the concentrations are less than the MCL. ICs in the form of groundwater use restrictions will remain in place until RAOs are achieved, thereby preventing human exposure. Since Alternative 5 will attain cleanup goals before the other alternatives, it will be more protective of human health and the environment. The selected remedy will not pose unacceptable short-term risks or cross-media impacts. Rigorous health and safety procedures and proper construction safety measures will mitigate the short-term risks associated with delivering in situ treatment amendments to the subsurface. The in situ treatment by nature treats the COCs in place, therefore minimizing the potential for cross-media impacts.

2.12.1.3 Site SS090 (Golf Course Area)

The selected remedy (Alternative 8 – Limited Excavation, Enhanced Bioremediation, MNA, and ICs) is protective of human health and the environment. Enhanced bioremediation of PCE and TCE in the saturated and unsaturated zones will accelerate the remediation of the groundwater plumes to the protective MCL of 5 µg/L for both PCE and TCE within a reasonable timeframe. Remediation of the unsaturated source zone through excavation and enhanced bioremediation will prevent further migration of contaminants from the source area to the saturated zone. The natural attenuation of the residual PCE and TCE contaminants outside of the treatment zones will be monitored until the concentrations are less than the MCLs. ICs in the form of groundwater use restrictions will remain in place until RAOs are achieved, thereby preventing human exposure.

The selected remedy for Site SS090 (Golf Course Area) will not pose unacceptable short-term risks or cross-media impacts. Rigorous health and safety procedures will mitigate the short-term risks associated with excavation and backfill work. Excavating contaminated soil in the unsaturated zone, replacing the excavated soil with uncontaminated sand or gravel mixed with a carbon substrate, and recirculating contaminated groundwater through the sand/gravel mixture will result in enhanced bioremediation of the residual contaminants in the soil and the groundwater in the source area.

2.12.2 Compliance with Applicable or Relevant and Appropriate Requirements

Remedial actions must comply with both Federal and State ARARs, which are legal standards, criteria, or limitations of federal and state environmental laws and regulations.

ARARs fall into three categories: chemical-, location-, and action-specific. Chemical-specific ARARs are health- or risk-management-based numbers that provide concentration limits for the occurrence of a chemical in the environment. Location-specific ARARs restrict activities in certain sensitive environments. Action-specific ARARs are activity- or technology-based, and typically control remedial activities that generate hazardous wastes (such as with those covered under RCRA). Offsite shipment, treatment, and disposal of excavated contaminated soil invoke action-specific ARARs. Criteria to be considered are non-promulgated advisories or guidance issued by federal or state government that are not legally binding and do not have the status of potential ARARs. However, in many circumstances, to be considered criteria are considered along with ARARs.

Table 2-19 summarizes the ARARs for the selected remedies at OU 9. Also, it includes a description of how each selected remedy addresses the ARARs. The selected remedies comply with the chemical-, location-, and action-specific ARARs. The implementation of the remedies is required to meet the substantive portions of these requirements and is exempt from administrative requirements, such as permitting and notifications.

2.12.3 Cost Effectiveness

The selected remedies are cost effective and represent a reasonable value for the money to be spent. In making this determination, the following definition was used: “A remedy shall be cost-effective if its costs are proportional to its overall effectiveness” (40 CFR 300.430[f][1][ii][D]). This determination was accomplished by evaluating the overall effectiveness of those alternatives that satisfy the threshold criteria (that is, is protective of human health and the environment and ARAR compliant).

Overall effectiveness was evaluated by assessing the following three of the five balancing criteria in combination: long-term effectiveness and permanence, reduction in TMV through treatment, and short-term effectiveness. Overall effectiveness was then compared to costs to determine cost effectiveness. The overall effectiveness of the selected remedies for the different areas at OU 9 includes:

2.12.3.1 Site SS108 (800/900 Area)

The cost of the selected remedy (Alternative 2) is approximately \$0.12 million, with most of the cost associated with groundwater monitoring. The selected remedy has good long-term effectiveness because it has the potential to achieve the RAOs and document CT concentrations remain below the MCL without leaving long-term residual contamination. Implementation of groundwater monitoring will show that a reduction in TMV has been achieved. The selected remedy presents minimal short-term risk to the community or workers and achieves the RAOs in a relatively short timeframe.

2.12.3.2 Site SS089 (1100 Area)

The selected remedy (Alternative 5) is the most cost effective as compared to the other remedial alternatives. The estimated cost of Alternative 5 is \$2.2 million. Alternative 5 is expected to achieve RAOs in a much shorter timeframe than the other alternatives for Site SS089 (1100 Area), and costs the same or less than Alternatives 3 and 4. The estimated cost of Alternative 2 (\$1.1 million) is less than the estimated cost of Alternative 5, but the time to reach RAOs under Alternative 5 is approximately one-third the time required for Alternative 2.

2.12.3.3 Site SS090 (Golf Course Area)

The selected remedy (Alternative 8) is cost-effective as compared to the other remedial alternatives. The estimated cost of Alternative 8 is \$2.4 million, which is less than the estimated costs of most of the other alternatives with the exception of Alternatives 2 and 3. The time to achieve RAOs for Alternative 8 is approximately 45 years less than the time required to achieve RAOs under Alternative 2. For roughly the same cost as Alternatives 2 and 3, Alternative 8 is predicted to have a significantly shorter restoration timeframe than Alternative 2 and a slightly shorter restoration timeframe than Alternative 3. Therefore, Alternative 8 is cost effective compared to the other remedial alternatives.

2.12.4 Utilization of Permanent Solutions and Alternative Treatment Technologies

The USAF has determined that the selected remedies for Sites SS108 (800/900 Area), SS089 (1100 Area), and SS090 (Golf Course Area) represent the maximum extent to which permanent solutions and treatment technologies can be used in a practicable manner at these sites. Of those alternatives that are protective of human health and the environment and comply with ARARs, the USAF has determined that the selected remedies provide the best balance of tradeoffs in terms of the five balancing criteria. In addition, the selected remedies consider the statutory preference for treatment as a principal element; bias against offsite treatment and disposal; and consider state and community acceptance.

The selected remedies result in permanent cleanup of TCE- and PCE-contaminated groundwater through enhanced bioremediation at Site SS090 (Golf Course Area). Additionally, source material at Site SS090 (Golf Course Area) will be permanently removed or treated through excavation and disposal of contaminated soil and in situ bioreactor treatment. In situ treatment will result in permanent cleanup of TCE-contaminated groundwater at Site SS089 (1100 Area). Finally, ICs and confirmation sampling will verify the natural permanent cleanup of CT at Site SS108 (800/900 Area). The selected remedies satisfy the criteria for long-term effectiveness by remediating dissolved-phase groundwater COCs. The selected remedies present some short-term risks to site workers during implementation of the remedy, but these risks can be controlled using standard health and safety practices and are similar to risks associated with other alternatives. No implementability issues set the selected remedies apart from the other alternatives evaluated.

2.12.5 Preference for Treatment as a Principal Element

The NCP establishes the expectation that treatment will be used to address the contaminants at a site wherever practicable (40 CFR 300.430[a][1][iii][A]). The selected remedies satisfy the statutory preference for treatment as a principal element to reduce the TMV of the COCs. For Site SS108 (800/900 Area), confirmation sampling will show that MNA, while not treatment, has resulted in TMV reduction through natural processes; therefore, no further treatment is required. The selected remedy for Site SS089 (1100 Area) includes treatment of TCE by biodegradation, which is enhanced by a carbon substrate to create better geochemical conditions for the native microorganisms to degrade the TCE. The selected remedy for Site SS090 (Golf Course Area) consists of treatment of the source zone and of the groundwater plumes through limited excavation and in situ enhanced bioremediation. MNA, while not treatment, is a component of the remedy at Site SS090 (Golf Course Area) where it is anticipated to reduce contaminant concentrations through natural processes within the saturated and unsaturated zones outside the enhanced bioremediation treatment zone.

2.12.6 Five-Year Review Requirements

CERCLA Section 121(c) and NCP Section 300.430(f)(4)(ii) requires a five-year review if the remedial action results in contaminants remaining onsite above levels that allow for UU/UE. A statutory review will be conducted within 5 years after initiation of remedial actions because the selected remedies will result in contaminants remaining onsite above levels that allow for UU/UE. The objective of the five-year review will be to ensure that the remedies are, or will be, protective of human health and the environment. These five-year reviews will continue until UU/UE conditions are attained.

2.13 Documentation of Significant Changes

No significant changes were made to the selected alternatives since the OU 9 Proposed Plan (EA 2014c) was finalized.

TABLE 2-1

Previous Site Investigations and Remediation Activities at Operable Unit 9

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Investigation	Contractor/Year	Summary
UST Investigation and Removal at Building 1141	Engineering Science 1991	The USAF investigated, removed, and closed a UST near Building 1141 at Site SS089 (1100 Area) in the early 1990s as part of the UST Program (Engineering Science 1991; CH2M HILL 2005a).
Pond 7 Preliminary Assessment/SI Report	ERM 1993	Pond 7 (Site SD040) was labeled as Pond 6 in this document (ERM 1993). The investigation included sampling of surface soil, subsurface soil, sediment, surface water, and groundwater. Results of the investigation were used to support a subsequent NFRAP decision document.
SAPA	MW 1994	<p>OU 9 originally consisted of all areas of environmental concern at Hill AFB not included in the other IRP sites of Hill AFB (MW 2000). Because of the size of OU 9, the area was divided into South and North Areas. The SAPA (MW 1994) and NAPA (MW 1995) began in 1993 and 1995, respectively.</p> <p>The SAPA (MW 1994) was conducted to gather information regarding potential releases of contaminants in the South Area of Hill AFB. The study focused on historical releases from the industrial wastewater, storm sewers, and buildings associated with industrial activity. The report summarized locations of potential source areas on a series of maps and tables containing current and historical information. Data were collected on buildings, sewer lines, catch basins, manholes, stormwater discharge ponds, salvage and storage yards, and areas where staining was observed on aerial photographs. The report grouped the findings according to geographical location, similarity of contaminants and sources, hydrogeology, surface characteristics, age, source size, and source complexity. Ten sampling areas were formed based on the grouping criteria.</p> <p>The assessment served as a basis to eliminate many facilities and areas from further investigation. Also, it reduced the amount of unknown information associated with historical activities and provided a framework for future preliminary assessment and SI activities.</p>
NAPA	MW 1995	<p>The NAPA (MW 1995) was conducted to gather information regarding potential releases of contaminants to soil, surface water, and groundwater within the North Area of Hill AFB. The study focused on buildings associated with industrial activity and reviewed existing information acquired during the SAPA. Interviews were conducted with current and former Hill AFB personnel. Design drawings were collected with data regarding industrial sewers, chemical storage, USTs, waste disposal, and maintenance areas and overlaid them on current Base maps using geographic information system. More than 17,000 data records were reviewed and 311 buildings of potential concern were identified. The report grouped facilities from 1 to 3 with Group 1 having the highest potential for chemical release.</p> <p>Facilities included in Groups 1 and 2 were recommended for site reconnaissance and a re-evaluation of the need for additional investigation. Facilities in Group 3 were recommended for no further investigation. The assessment served as a basis to eliminate many facilities and areas from further investigation. Also, it reduced the amount of unknown information associated with historical activities and provided a framework for future SI activities.</p>

TABLE 2-1

Previous Site Investigations and Remediation Activities at Operable Unit 9

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Investigation	Contractor/Year	Summary
PCB Delineation Report for Buildings 2042 and 2403, and the Used Transformer Storage Yard	MW 1998	This investigation (MW 1998) was initiated due to detections of PCBs at Sites OT093 (Zone 9 Transformer Yard), SS094 (Building 2402), and SS095 (Building 2403) during the North Area SI. The investigation delineated areas of surface soil containing PCB concentrations exceeding levels allowed by TSCA. The total area of soil exceeding screening levels measured less than 6,000 square ft.
PCB Delineation Report for Buildings 2042 and 2403, and the Used Transformer Storage Yard	MW 1999	This report (MW 1999) documented removal and offsite disposal of approximately 557 cubic yards of PCB-impacted material at the three PCB sites. The material was removed to a TSCA-permitted landfill. Confirmation samples determined that PCB concentrations in remaining soil were less than the TSCA limit of 1 mg/kg.
OU 9 North Area SI	MW 2000	The North Area SI (MW 2000) was conducted to evaluate whether environmental contamination was present at the facilities of potential concern identified in the NAPA and to categorize each facility according to its potential threat to human health and the environment. The report summarized results of field sampling and presented final recommendations for each facility of potential concern. Facilities posing little to no risk were recommended for NFA.
Basewide CPT Investigation	MW 2001	The Basewide CPT Investigation (MW 2001) collected groundwater data at sites around the perimeter of the Base, and in areas where there was a lack of prior investigation under other CERCLA investigations. Samples were analyzed for VOCs. Results were used to recommend further investigation or rule out areas for further investigations.
OU 9 South Area SI	CH2M HILL 2001	The South Area SI (CH2M HILL 2001) was conducted to evaluate whether environmental contamination was present at the facilities of potential concern identified in the SAPA and to categorize each facility according to its potential threat to human health and the environment. A field investigation was performed in two phases to evaluate the presence of contaminants. The first phase consisted of site reconnaissance and data research. The second phase of investigation consisted of subsurface soil sampling. The report summarized results of field sampling and presented final recommendations for each facility of potential concern. Facilities posing little to no risk were recommended for NFA.
Building 786 NFRAP Decision Document	CH2M HILL 2002	The Site SS092 (Building 786) NFRAP document (CH2M HILL 2002b) summarized results of the North Area SI and a June 2002 investigation at the pesticide storage area. Trace concentrations of pesticides and herbicides were detected, but not above residential risk-based screening levels. The document concluded that the site does not pose a threat to human health or the environment, and NFA is recommend for the site.
Pond 1 EE/CA	CH2M HILL 2002	The EE/CA (CH2M HILL 2002a) summarized results of multiple previous investigations at Pond 1 (Site SD034) and addressed the rationale for selecting a removal action. The EE/CA concluded that portions of the pond sediment were contaminated with PAHs and metals at concentrations that exceed residential risk-based standards to a depth of up to 4 ft bgs. Additionally, a PCB concentration at one location exceeded TSCA limits. The document recommended onsite consolidation and capping of the contaminated sediment. This alternative was selected in an action memorandum later that year (CH2M HILL 2002c).

TABLE 2-1

Previous Site Investigations and Remediation Activities at Operable Unit 9

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Investigation	Contractor/Year	Summary
OU 11 Analytical Data Report, 1 May 2001 – 31 January 2002	CH2M HILL 2002	This Analytical Data Report (CH2M HILL 2002d) was part of the OU 11 RI/FS process. Site SS090 (Golf Course Area) was included in OU 11 during this time period; a CPT/HydroPunch investigation and sampling of monitoring wells were performed at Site SS090 (Golf Course Area).
Pond 3 EE/CA	CH2M HILL 2003	The EE/CA (CH2M HILL 2003) summarized results of multiple previous investigations at Site SD023 (Pond 3 Area) and addressed the rationale for selecting a removal action. The EE/CA concluded that portions of the pond sediment was contaminated with arsenic at concentrations that exceed residential risk-based standards. The document recommended removal and offsite disposal of approximately 200 cubic yards of sediment to a depth of 4 ft bgs.
Pond 1 Remedial Action Report	CH2M HILL 2004	The remedial action construction report for Site SD034 (Pond 1 Area) (CH2M HILL 2004a) documented the excavation, consolidation, and capping of 2,270 cubic yards of contaminated sediment. The contaminated sediment were moved to the northwest corner of the pond and capped with a layer of clean soil at least 8 ft thick. New stormwater piping and structures also were constructed, and the pond was expanded to the east and south. Confirmation samples in the excavation area confirmed that the remaining soil/sediment contained contaminant concentrations below residential risk-based levels.
Pond 3 Action Memorandum	CH2M HILL 2004	The action memorandum for Site SD023 (Pond 3 Area) (CH2M HILL 2004b) documented the approval of the remedy proposed in the EE/CA (CH2M HILL 2003).
Pond 3 Remedial Action Construction Report	CH2M HILL 2004	The remedial action construction report (CH2M HILL 2004c) for Site SD023 documented the removal and offsite disposal of 70 cubic yards of arsenic-impacted sediment. Confirmation samples confirmed that the remaining soil/sediment contained arsenic concentrations below the background level established in the South Area SI report (CH2M HILL 2001).
OU 9 RI	CH2M HILL 2005	<p>The RI Report (CH2M HILL 2005a) documented analytical results from soil, groundwater, and air sampling in Sites SS108 (800/900 Area) SS089 (1100 Area), and SS090 (Golf Course Area). The RI Report included an evaluation of risk to human health and the environment associated with past waste disposal practices.</p> <p>The RI Report concluded that Sites SS089 (1100 Area) and SS090 (Golf Course Area) had relatively stable contaminant concentrations. The 800/900 Area and Pond 7 Area showed decreasing and low concentrations of CT and TCE, respectively.</p>
Pond 7 NFRAP Decision Document	CH2M HILL 2005	The Site SD040 (Pond 7) NFRAP document (CH2M HILL 2005b) summarized the results of historical investigations at the Pond 7 Area. The document concluded that the results of the soil and groundwater sampling survey indicate that the current conditions at the Pond 7 Area do not pose a risk to human health and the environment. There was marginal non-carcinogenic risk to a hypothetical future resident on the Pond 7 Area from domestic use of the shallow groundwater, but there were no plans to use the shallow groundwater for potable use. The document recommended NFA for Site SD040.
OU 9 FS	CH2M HILL 2005	The FS Report (CH2M HILL 2005c) documented development, screening, and detailed analysis of potential remedial alternatives for the OU 9 sites. The report was based on SI and risk assessment data documented in the OU 9 RI Report.

TABLE 2-1

Previous Site Investigations and Remediation Activities at Operable Unit 9

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Investigation	Contractor/Year	Summary
2009 Soil and Soil Gas Investigation	CH2M HILL 2010	The report (CH2M HILL 2010b) documented results of an investigation into possible source areas at Sites SS089 (1100 Area) and SS090 (Golf Course Area). The investigation concluded that no further investigation or evaluation of potential source areas was warranted within Site SS089 (1100 Area). The report identified a source area of PCE and TCE at Site SS090 (Golf Course Area).
Revised OU 9 FS	CH2M HILL 2010	The study (CH2M HILL 2010a) was a revision of the previous 2005 FS. Following a review, the EPA requested additional information to support an MNA remedy for Sites SS108, SS089, and SS090 (800/900 Area, 1100 Area, and Golf Course Area, respectively). This Revised FS Report included an updated conceptual site model and a re-evaluation of the remedial alternatives.
OU 9 FS Supplement	EA 2014	A supplement to the Revised FS Report (EA 2014a) was prepared to evaluate one additional remedial alternative for Site SS089 (1100 Area) and one additional remedial alternative for Site SS090 (Golf Course Area). The purpose of this supplement was to present a description, remedial timeframe, and cost estimate for these new alternatives and a comparison of the new alternatives for these two sites to the alternatives presented in the Revised FS Report. Also, it documented a change in the remedial timeframe for Site SS108 (800/900 Area).
OU 9 Proposed Plan	EA 2014	The Proposed Plan (EA 2014c) summarized the remedial alternatives, evaluation of alternatives, and the preferred alternatives for each site. The Proposed Plan was issued to solicit public input on the preferred alternative, which were MNA and ICs for Site SS108 (800/900 Area); enhanced bioremediation and ICs at Site SS089 (1100 Area); and enhanced bioremediation, MNA, and ICs at Site SS090 (Golf Course Area).

NOTES:

AFB = Air Force Base.

bgs = Below ground surface.

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.

CPT = Cone penetration test.

CT = Carbon tetrachloride.

EA = EA Engineering, Science, and Technology, Inc., PBC.

EE/CA = Engineering Evaluation/Cost Analysis.

EPA = U.S. Environmental Protection Agency.

ERM = ERM-Rocky Mountain, Inc.

FS = Feasibility Supplement.

ft = Feet(foot).

IC = Institutional control.

IRP = Installation Restoration Program.

mg/kg = Milligram(s) per kilogram.

MNA = Monitored natural attenuation.

MW = Montgomery Watson.

NAPA = North Area Preliminary Assessment.

NFA = No Further Action.

NFRAP = No Further Response Action Planned.

OU = Operable Unit.

PAH = Polycyclic aromatic hydrocarbon.

PCB = Polychlorinated biphenyl.

PCE = Tetrachloroethene.

RI = Remedial Investigation.

SAPA = South Area Preliminary Assessment.

SI = Site Inspection.

TCE = Trichloroethene.

TSCA = Toxic Substances Control Act.

USAF = U.S. Air Force.

UST = Underground storage tank.

VOC = Volatile organic compound.

TABLE 2-2

Current Data Summary for Contaminants of Concern in Groundwater

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

	Current On-Base Maximum Concentration⁽¹⁾ (µg/L)	Current Off-Base Maximum Concentration⁽¹⁾ (µg/L)	Remediation Goals (µg/L)⁽²⁾
Site SS108 (800/900 Area)⁽³⁾			
CT	4.8	NA	5
Site SS089 (1100 Area)⁽⁴⁾			
TCE	81.9	31.5	5
Site SS090 (Golf Course Area)⁽⁵⁾			
PCE	410	ND	5
TCE	110	ND	5

NOTES:

(1) Concentration data are for groundwater samples from monitoring wells. Current concentration data are from June 2014 and July 2014, and were obtained from the Environmental Resources Program Information Management System (ERPIMS).

(2) Remediation goals are the Federal and Utah MCLs.

(3) Data from groundwater Monitoring Well U9-014.

(4) On-Base data from groundwater Monitoring Well U9-1001; off-Base data from Well U10-005.

(5) On-Base data from groundwater Monitoring Well U9-100; off-Base data from Well U11-015.

µg/L = Microgram(s) per liter.

CT = Carbon tetrachloride.

MCL = Maximum Contaminant Level.

NA = Not applicable; Site SS108 (800/900 Area) located on-Base only.

ND = Non-detect.

PCE = Tetrachloroethene.

TCE = Trichloroethene.

Federal MCL: [U.S. Environmental Protection Agency 2013](http://www.epa.gov/safewater/contaminants/index.html)

<http://www.epa.gov/safewater/contaminants/index.html>.

Utah MCL: <http://www.rules.utah.gov/publicat/code/r309/r309-200.htm>.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 2-3

Toxicity Factors

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Variable	Abbreviation	Units	PCE	TCE	CT
Oral Slope Factor – Cancer	SF _o	(mg/kg-day) ⁻¹	2.1E-03	4.6E-02	7.0E-02
Inhalation Unit Risk Factor – Cancer	IUR	(µg/m ³) ⁻¹	2.6E-07	4.1E-06	6.0E-06
Oral Reference Dose – Non-cancer	RfD	mg/kg-day	6.0E-03	5.0E-04	4.0E-03
Inhalation Reference Concentration – Non-cancer	RfC	µg/m ³	4.0E-02	2.0E-03	1.0E-01
Gastrointestinal Absorption Factor	GIABS	unitless	1	1	1

NOTES:

"--" = not a site-specific COC.

µg/L = Microgram(s) per liter.

µg/m³ = Microgram(s) per cubic meter.

COC = Contaminant of concern.

CT = Carbon tetrachloride.

mg/kg-day = Milligram(s) per kilogram per day.

PCE = Tetrachloroethene.

TCE = Trichloroethene.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 2-4

Exposure Factors

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Variable	Abbreviation	Units	Value	
			Child Resident	Adult Resident
Exposure duration	ED	year	6	20
Averaging time – cancer	ATc	days	25,550	25,550
Averaging time – non-cancer	ATnc	days	9,490	9,490
Exposure frequency	EFr	day/year	350	350
Tap water dermal exposure time	ETdermal	hour/event	0.54	0.71
Exposure time	ET	hour/day	24	24
Body weight	BW	kilograms	15	80
Water intake rate – child	IRW	liter/day	0.78	2.5
Dermal event frequency	EVF	per day	1	1
Volatilization factor of Andelman	K	liter/cubic meter	0.5	0.5
Skin surface area	SA	square centimeters	6,378	20,900
Soil gas to indoor air attenuation factor ⁽¹⁾	AF	unitless	0.01	0.01

NOTES:

⁽¹⁾ Soil gas values based on previously accepted attenuation factor (0.01) for transfer of contaminants from soil gas to indoor air at OU 9 (Table 1-3 in CH2M HILL 2010a).

OU = Operable Unit.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 2-5
Risk Assessment Equations
Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Applicable OU 9 Sites			Exposure Scenario				Media, Pathways and Intake Routes			Concentration Factors			Exposure Factors and Results ⁽²⁾					Toxicity Factors and Risk Results														
																		Cancer					Non-cancer									
800/900 Area	1100 Area	Golf Course Area	On-Base Resident		On-Base Commercial/Industrial Worker		Primary Media	Pathways	Intake Routes ⁽⁴⁾	Measured Concentrations		Intermedia Partitioning Factors		Exposure Point Concentration		Receptor-specific Exposure Factors			Exposure Result		Exposure Result		Cancer Toxicity Factors		Cancer Results		Exposure Result		Non-cancer Toxicity Factors		Non-cancer Results	
			Current	Future	Current	Future																										
X	X	X		X ⁽¹⁾			Groundwater	Tap Water Ingestion	ING	C _w			=	C _w	C _w	•	<div>IRW × EF × ED</div>	=	Dose _{LifeAvg}	Dose _{LifeAvg}	•	SF _o	=	ELCR	Dose _{LifeAvg}	•	<div>1</div>	=	HQ			
X	X	X		X ⁽¹⁾				Tap Water Volatilization	INH	C _w	•	K _{house}	=	C _{ia}	C _{ia}	•	<div>ET × (24 hr/day)⁻¹ × EF × ED</div>	=	Conc _{LifeAvg}	Conc _{LifeAvg}	•	IUR	=	ELCR	Conc _{LifeAvg}	•	<div>1</div>	=	HQ			
X	X	X		X ⁽¹⁾				Tap Water Dermal Contact	DER	C _w			=	C _w			<div>DA_{event} × SA × EF × ED × EVF</div>	=	Dose _{LifeAvg}	Dose _{LifeAvg}	•	SF _d	=	ELCR	Dose _{LifeAvg}	•	<div>1</div>	=	HQ			
		X		X ⁽¹⁾		X ⁽³⁾		Soil Vapor	Vapor Intrusion	INH	C _{sv}	•	AF	=	C _{ia}	C _{ia}	•	<div>ET × (24 hr/day)⁻¹ × EF × ED</div>	=	Conc _{LifeAvg}	Conc _{LifeAvg}	•	IUR	=	ELCR	Conc _{LifeAvg}	•	<div>1</div>	=	HQ		
																		<div>AT</div>														

NOTES:
⁽¹⁾ Age-weighted ELCR = Σ Adult,Child ELCR.
Age-weighted HQ = Σ Adult,Child HQ.
⁽²⁾ The values of some exposure factors vary by receptor, age, and health endpoint (cancer versus non-cancer).
⁽³⁾ Not quantified. Assumed to be bounded by the hypothetical future resident estimates.
⁽⁴⁾ DER = Dermal Contact.

AF = Soil Gas to Indoor Air Attenuation Factor.
AT = Averaging Time.
BW = Body Weight.
C_{ia} = Concentration—Indoor Air.
Conc_{LifeAvg} = Lifetime Averaged Concentration.
C_{sv} = Concentration—Soil Vapor.
C_w = Concentration—Water.
DA_{event} = Dermally Absorbed Dose per Event (Table 2-7 for equations and assumptions).
Dose_{LifeAvg} = Lifetime Averaged Dose.
ED = Exposure Duration.

EF = Exposure Frequency.
ELCR = Excess Lifetime Cancer Risk.
ET = Exposure Time.
EVF = Event Frequency.
GIABS = Gastrointestinal Absorption Factor.
HQ = Hazard Quotient (non-cancer).
hr = Hour.
ING = Ingestion.
INH = Inhalation.
IR = Ingestion Rate.

IRW = Water intake rate.
IUR = Inhalation Unit Risk (cancer).
K_{house} = Tap Water to Indoor Air Partitioning Factor.
RfC_i = Inhalation Reference Concentration (non-cancer).
RfD_d = Dermal Reference Dose (non-cancer) = RfD_o * GIABS.
RfD_o = Oral Reference Dose (non-cancer).
SA = Skin Surface Area.
SF_d = Dermal Slope Factor (cancer) = SF_o / GIABS.
SF_o = Oral Slope Factor (cancer).

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 2-6

Dermally Absorbed Dose Calculations

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

DA_{event} (microgram per square centimeter-event) is calculated for organic compounds as follows :

$$\text{If } t_{event} \leq t^*, \text{ then: } DA_{event} = 2 FA \times K_p \times C_w \sqrt{\frac{6 \tau_{event} \times t_{event}}{\pi}}$$

$$\text{If } t_{event} > t^*, \text{ then: } DA_{event} = FA \times K_p \times C_w \left[\frac{t_{event}}{1 + B} + 2 \tau_{event} \left(\frac{1 + 3 B + 3 B^2}{(1 + B)^2} \right) \right]$$

Where:

B = Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the VE (dimensionless).

DA_{event} = Absorbed dose per event (microgram per square centimeter-event).

FA = Fraction absorbed water (dimensionless).

K_p = Dermal permeability coefficient of compound in water (cm/hr).

C_w = Chemical concentration in water (microgram per cubic centimeter) (Table 2-2).

τ_{event} = Lag time per event (hr/event).

t_{event} = Event duration (hr/event) (see "Tap Water Dermal Exposure Time" in Table 2-4).

t^* = Time to reach steady-state (hr) = τ_{event} .

Chemical	K_p	t^*	τ_{event}	FA	B
CT	0.016	1.8	0.76	1	0.08
PCE	0.033	2.1	0.89	1	0.2
TCE	0.012	1.4	0.57	1	0.05

NOTES:

cm/hr = Centimeter per hour.

CT = Carbon tetrachloride.

EPA = U.S. Environmental Protection Agency.

hr = Hour.

PCE = Tetrachloroethene.

TCE = Trichloroethene.

VE = Viable epidermis.

Values downloaded from EPA online screening level calculator on December 11, 2014 (http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) (EPA 2014c).

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 2-7

Risk Assessment Update Results

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Risk Endpoint	Analyte	Groundwater as Tap Water			Soil Gas to Future Hypothetical Residents via Vapor Intrusion
		SS108 (800/900 Area)	SS089 (1100 Area)	Site SS090 (Golf Course Area)	Site SS090 (Golf Course Area)
Non-cancer Hazard Quotient	PCE	--	--	9	0.6
	TCE	--	30	40	--
	CT	0.08	--	--	--
	Hazard Index:	0.08	30	50	0.6
ELCR	PCE	--	--	4.E-05	2E-06
	TCE	--	2.E-04	3.E-04	--
	CT	1.E-05	--	--	--
	Cumulative ELCR:	1.E-05	2.E-04	3.E-04	2.E-06

NOTES:

"--" = not a site-specific COC.

COC = Contaminant of concern.

CT = Carbon tetrachloride.

ELCR = Excess lifetime cancer risk.

PCE = Tetrachloroethene.

TCE = Trichloroethene.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 2-8

Data Summary for Contaminants of Concern in Soil for Site SS090 (Golf Course Area)

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

	Maximum Concentration ⁽¹⁾ (mg/kg)	Remediation Goals ⁽²⁾ (mg/kg)
Site SS090 (Golf Course Area)		
PCE	1.6	0.046
TCE	0.15	0.036

NOTES:

⁽¹⁾ Maximum concentration values for Site SS090 (Golf Course Area) were obtained from the OU 9 Revised FS Report (CH2M HILL 2010a) and are located on-Base.

⁽²⁾ Soil screening levels for Golf Course soil are based on the MCL-based screening levels for protection of groundwater, derived from the EPA Regional Screening Level table (EPA 2015) times an assumed dilution attenuation factor of 20. These screening levels are lower than those levels for residential exposure.

EPA = U.S. Environmental Protection Agency.

FS = Feasibility Study.

MCL = Maximum Contaminant Level.

mg/kg = Milligram(s) per kilogram.

OU = Operable Unit.

PCE = Tetrachloroethene.

TCE = Trichloroethene.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 2-9

Summary of Remedial Components Evaluated for Operable Unit 9

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Remedial Components	Remedial Component Description
1 – No Action	This remedial component entails no further action to remove, remediate, monitor, or restrict access to the groundwater other than what has already been implemented. Although unacceptable as a remedial alternative, this response is required by the NCP to be evaluated for comparative purposes, where it is used as a baseline against which all other alternatives will be compared.
2 – Institutional Controls	ICs control access to contaminated groundwater and soil at OU 9. No new wells are permitted in the restricted areas. In addition, no change applications that propose to transfer water rights into these areas will be granted. Limited groundwater monitoring is required as part of the IC response action. Data are used to track the direction and rate of movement of each contaminant plume. When the RAOs are met, the State Engineer will consider allowing construction of wells in these off-Base areas.
3 – Monitored Natural Attenuation	MNA is distinguished from no action in that natural attenuation assumes contaminant concentrations are being reduced by various naturally occurring physical, chemical, and biological processes. Primary natural attenuation processes include dilution, dispersion, biodegradation, volatilization, and adsorption. Under this general response action, unaugmented, natural, intrinsic processes are used, and a monitoring program would be implemented to track remedial progress.
4 – Containment	Containment refers to minimizing spread of groundwater contaminants through active or passive controls. Active control can be accomplished with pumping wells, trenches, or horizontal drains while passive control can be achieved using a slurry or sheet-pile wall.
5 – In Situ Treatment	In situ treatment of groundwater entails treating groundwater while it is in the aquifer, which can be achieved by applying physical/chemical, biological, or thermal techniques. Possible approaches to in situ (in place) treatment include in situ chemical oxidation, enhanced bioremediation, and phytoremediation.
6 – Collection/ Treatment/ Discharge	Groundwater and/or soil gas will be extracted from the subsurface using vertical or horizontal pumping wells, SVE networks, horizontal drains, or trenches; and treated aboveground, if necessary. Ultimately, the extracted groundwater will be discharged through the sanitary sewer to a publicly owned treatment works for further treatment.
7 – Removal	Soil containing contaminant concentrations greater than cleanup goals would be excavated, treated if required, and disposed. Traditional methods that excavate a large area may include trenching with shoring or an open pit with setbacks. If space is limited, using sheet piles and braces would allow for a narrow excavation and a lower volume of soil. Following excavation, the soil would be sampled to determine the appropriate disposal method. The soil would then be transported to a disposal facility for incineration, land disposal, or treatment, depending on the contaminant concentrations.

NOTES:

IC = Institutional control.

MNA = Monitored natural attenuation.

NCP = National Oil and Hazardous Substances Pollution Contingency Plan.

OU = Operable Unit.

RAO = Remedial action objective.

SVE = Soil vapor extraction.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 2-10

Remedial Components for Site SS108 (800/900 Area)

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Remedial Alternative Name	Treatment Technologies	Containment Component	ICs	O&M Requirements	Monitoring Requirements
1: No Action	NA ⁽¹⁾	NA ⁽²⁾	None	None	None
2: MNA and ICs	Biodegradation, dilution, dispersion, and sorption naturally attenuate the groundwater plume	NA ⁽²⁾	Utah DWRi groundwater use restrictions (off-Base) and USAF groundwater and land use restrictions (on-Base)	Sampling, analysis, and reporting	RA-O performance monitoring of CT concentrations in groundwater

NOTES:

⁽¹⁾ Although natural processes would treat contamination as part of Alternative 1, these processes would not be monitored or documented.

⁽²⁾ Containment components are not applicable because the available information indicates that the plume has attenuated (Section 2.4.7 of the text).

CT = Carbon tetrachloride.

DWRi = Division of Water Rights.

IC = Institutional control.

MNA = Monitored natural attenuation.

NA = Not applicable.

O&M = Operation and maintenance.

RA-O = Remedial action-operations.

USAF = U.S. Air Force.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 2-11

Remedial Components for Site SS089 (1100 Area)

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Remedial Alternative Name	Treatment Technologies	Containment Component	ICs	O&M Requirements	Monitoring Requirements
1: No Action	NA ⁽¹⁾	NA ⁽²⁾	None	None	None
2: Existing Phytoremediation, MNA, and ICs	(1) Removal of contamination by existing mature Poplar trees and (2) natural attenuation by biodegradation, dilution, dispersion, sorption, and storage in immobile domains	NA	Utah DWRI groundwater use restrictions (off-Base) and USAF groundwater and land use restrictions (on-Base)	Sampling, analysis, and reporting	Collection of natural attenuation process data and RA-O performance monitoring of TCE concentrations in groundwater
3: Enhanced Phytoremediation, MNA, and ICs	(1) Supplementing existing phytoremediation by planting additional trees, and (2) natural attenuation as previously described	NA	Utah DWRI groundwater use restrictions (off-Base) and USAF groundwater and land use restrictions (on-Base)	Maintenance of health of trees, sampling, analysis, and reporting	Collection of phytoremediation process data consisting of tree tissue or phyto-flux data, collection of natural attenuation process data, and RA-O performance monitoring
4: Groundwater Extraction and Discharge, Existing Phytoremediation, MNA, and ICs	(1) Physical extraction of contaminated groundwater and conveyance to a treatment facility, (2) existing phytoremediation as previously described, and (3) natural attenuation as described previously	NA	Utah DWRI groundwater use restrictions (off-Base) and USAF groundwater and land use restrictions (on-Base)	Maintenance of extraction system, sampling, analysis, and reporting	Performance monitoring of extraction system, collection of natural attenuation process data, and RA-O performance monitoring
5: Enhanced Bioremediation and ICs	Injection of a chemical, biological, or physical, agent to treat TCE-contaminated groundwater	NA	Utah DWRI groundwater use restrictions (off-Base) and USAF groundwater and land use restrictions (on-Base)	Sampling, analysis, and reporting	Performance monitoring bioremediation system, monitoring for treatment residuals, and RA-O performance monitoring

NOTES:⁽¹⁾ Although natural processes would treat contamination as part of Alternative 1, these processes would not be monitored or documented.⁽²⁾ Containment components are not applicable because the available information indicates that the plume is stable or contracting (Section 2.4.7 of the text).

DWRI = Division of Water Rights.

IC = Institutional control.

MNA = Monitored natural attenuation.

NA = Not applicable.

O&M = Operation and maintenance.

RA-O = Remedial action operations.

TCE = Trichloroethene.

USAF = U.S. Air Force.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 2-12

Remedial Components for Site SS090 (Golf Course Area)
Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Remedial Alternative Name	Treatment Technologies	Containment Component	ICs	O&M Requirements	Monitoring Requirements
1: No Action	NA ⁽¹⁾	None	None	None	None
2: Oil Shield, MNA, and ICs	(1) Sequestration and biodegradation of infiltrating contamination from the source zone and (2) natural attenuation by biodegradation, dilution, dispersion, sorption, and storage in immobile domains	Interception of contamination infiltrating toward the water table from the source zone	Utah DWRI groundwater use restrictions (off-Base) and USAF groundwater and land use restrictions (on-Base)	Periodic replenishment of oil shield, sampling, analysis, and reporting	Collection of natural attenuation process data and RA-O performance monitoring of PCE and TCE concentrations in groundwater
3: SVE, MNA, and ICs	(1) Physical removal of PCE and TCE from soil in the source zone by volatilization and (2) MNA as previously described	None	Utah DWRI groundwater use restrictions (off-Base) and USAF groundwater and land use restrictions (on-Base)	SVE system maintenance, vapor and groundwater sampling and analysis, and reporting	Performance monitoring of SVE system, collection of natural attenuation process data, and RA-O performance monitoring
4: SVE, In Situ Treatment, MNA, and ICs	(1) Physical removal of contamination from the source zone by volatilization, (2) injection of a chemical, biological, or physical, or biological agent to treat groundwater plumes, and (3) natural attenuation as previously described	None	Utah DWRI groundwater use restrictions (off-Base) and USAF groundwater and land use restrictions (on-Base)	Maintenance of SVE system, maintenance of injection system, sampling, analysis, and reporting	Performance monitoring of SVE and in situ treatment systems, monitoring for treatment residuals, collection of natural attenuation process data, and RA-O performance monitoring
5: Groundwater Extraction and Discharge, MNA, and ICs	(1) Extraction of contaminated groundwater and conveyance to a treatment facility and (2) natural attenuation as previously described	Hydraulic containment of groundwater hot spot beneath source zone	Utah DWRI groundwater use restrictions (off-Base) and USAF groundwater and land use restrictions (on-Base)	Maintenance of extraction system, sampling, analysis, and reporting	Performance monitoring of extraction system, collection of natural attenuation process data, and RA-O performance monitoring
6: Excavation, MNA, and ICs	(1) Removal of soil containing PCE and TCE in concentrations greater than RGs and off-site disposal at a licensed disposal facility and (2) natural attenuation as previously described	None	Utah DWRI groundwater use restrictions (off-Base) and USAF groundwater and land use restrictions (on-Base)	Sampling, analysis, and reporting	Characterization of excavated soil, confirmation sampling of soil near source zone, collection of natural attenuation process data, and RA-O performance monitoring

TABLE 2-12

Remedial Components for Site SS090 (Golf Course Area)
Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Remedial Alternative Name	Treatment Technologies	Containment Component	ICs	O&M Requirements	Monitoring Requirements
7: SVE, Phytoremediation, MNA, and ICs	(1) Physical removal of PCE and TCE from soil in the source zone by volatilization, (2) removal of groundwater contamination with planted trees, and (3) natural attenuation as previously described	None	Utah DWRi groundwater use restrictions (off-Base) and USAF groundwater and land use restrictions (on-Base)	Maintenance of SVE system, maintenance of the health of the trees, sampling, analysis, and reporting	Performance monitoring of SVE and phytoremediation systems, natural attenuation process data, and RA-O performance monitoring
8: Limited Excavation, Enhanced Bioremediation, MNA, and ICs	(1) Injection of carbon substrate to promote biodegradation of PCE and TCE in groundwater, (2) excavation of shallow contaminated soil from unsaturated zone within the source area, characterize excavated soil to determine proper treatment and/or disposal, off-site disposal of excavated soil at a licensed disposal facility, and backfill with uncontaminated sand and gravel mixed with carbon substrate and other additives to promote degradation of the PCE and TCE in the unsaturated zone, (3) recirculation of contaminated groundwater over uncontaminated sand/gravel carbon substrate mixed backfill, and (4) natural attenuation as previously described	None	Utah DWRi groundwater use restrictions (off-Base) and USAF groundwater and land use restrictions (on-Base)	Maintenance of injection system, sampling, analysis, and reporting	Characterization of excavated soil, performance monitoring of bioremediation system, monitoring for treatment residuals, collection of natural attenuation process data, and RA-O performance monitoring

NOTES:

⁽¹⁾ Although natural processes would treat contamination as part of Alternative 1, these processes would not be monitored or documented.

DWRi = Division of Water Rights.

IC = Institutional control.

MNA = Monitored natural attenuation.

NA = Not applicable.

O&M = Operation and maintenance.

PCE = Tetrachloroethene.

RA-O = Remedial action-operations.

SVE = Soil vapor extraction.

TCE = Trichloroethene.

USAF = U.S. Air Force.

TABLE 2-13

Distinguishing Features of Remedial Alternatives for Site SS108 (800/900 Area)

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Remedial Alternative Name	Key ARARs	Long-Term Reliability of Remedy	Characteristics of Treatment Residuals	Estimated Time of Implementation ⁽¹⁾	Estimated Remediation Time	Estimated Capital, Annual O&M, and Total Present Worth Costs ^{(1) (2)}	Expected Outcomes
1: No Action	<ul style="list-style-type: none"> UAC R311-211—Corrective Actions Cleanup Standards Policy—UST and CERCLA Sites 	None	NA	NA	NA	Capital = \$0 O&M = \$0 Total Present Worth = \$0	Natural attenuation may restore groundwater to potentially unrestricted use conditions, but there would be no verification.
	<ul style="list-style-type: none"> UAC R309-200-5—Monitoring and Water Quality: Drinking Water Standards 						
	<ul style="list-style-type: none"> UAC R315-101—Cleanup and Risk-based Closure Standards: RCRA, UST, and CERCLA Sites 						
2: MNA with ICs	<ul style="list-style-type: none"> UAC R311-211—Corrective Actions Cleanup Standards Policy—UST and CERCLA Sites 	Natural attenuation permanently reduces contaminant concentrations while ICs prevent unrestricted use minimal potential for remedy failure.	CT biodegrades to chloroform, dichloromethane, methylene chloride, methane, and carbon dioxide.	NA	2 years	Capital = \$0 O&M = \$119,000 Total Present Worth = \$121,000	Natural attenuation has already restored groundwater to potentially unrestricted use conditions. ICs expected to prevent exposure to contamination until verification sampling is completed.
	<ul style="list-style-type: none"> UAC R309-200-5—Monitoring and Water Quality: Drinking Water Standards 						
	<ul style="list-style-type: none"> UAC R315-101—Cleanup and Risk-based Closure Standards: RCRA, UST, and CERCLA Sites 						

NOTES:

⁽¹⁾ Estimated remedial timeframes and costs are presented in the OU 9 Revised FS Report (CH2M HILL 2010a) and the OU 9 FS Supplement (EA 2014a). Estimated costs are within a -30 to +50 percent accuracy range.

⁽²⁾ The present worth cost for Alternative 2 was calculated using a -1.4 percent real discount rate based on the remedial timeframe and the White House Office of Management and Budget Circular A-94 (http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c/). This is consistent with the guidance for federal facilities in the EPA guidance document, A Guide to Preparing and Documenting Cost Estimates During the FS (EPA 2000).

ARAR = Applicable or Relevant and Appropriate Requirement.

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.

CT = Carbon tetrachloride.

EA = EA Engineering, Science, and Technology, Inc., PBC.

EPA = U.S. Environmental Protection Agency.

FS = Feasibility Study.

IC = Institutional control.

MNA = Monitored natural attenuation.

NA = Not applicable.

O&M = Operation and maintenance.

OU = Operable Unit.

RCRA = Resource Conservation and Recovery Act.

UAC = Utah Administrative Code.

UST = Underground storage tank.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 2-14
Distinguishing Features of Remedial Alternatives for Site SS089 (1100 Area)
Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Remedial Alternative Name	Key ARARs	Long-Term Reliability of Remedy	Characteristics of Treatment Residuals	Estimated Time of Implementation	Estimated Remediation Time ⁽¹⁾	Estimated Capital, Annual O&M, and Total Present Worth Costs ^{(1) (2)}	Expected Outcomes
1: No Action	• UAC R311-211—Corrective Actions Cleanup Standards Policy—UST and CERCLA Sites	None	NA	NA	NA	Capital = \$0 O&M = \$0 Total Present Worth = \$0	Natural attenuation and existing phytoremediation may return groundwater to potentially unrestricted use conditions, but there would be no verification of the restoration.
	• UAC R309-200-5—Monitoring and Water Quality: Drinking Water Standards						
	• UAC R315-101—Cleanup and Risk-based Closure Standards: RCRA, UST, and CERCLA Sites						
2: Existing Phytoremediation, MNA, and ICs	• UAC R311-211—Corrective Actions Cleanup Standards Policy—UST and CERCLA Sites	Natural attenuation and phytoremediation permanently reduce and remove contaminant mass, respectively, while ICs prevent exposure; minimal potential for remedy failure.	No known toxic residuals from phytoremediation or from biodegradation.	NA	24 years	Capital = \$93,000 O&M = \$1,036,000 Total Present Worth = \$1,131,000	Natural attenuation and existing phytoremediation would restore groundwater to potentially unrestricted use conditions within a reasonable timeframe. ICs expected to prevent exposure to contamination until the RG is achieved. Phytoremediation system also will continue to capture greenhouse gases.
	• UAC R309-200-5—Monitoring and Water Quality: Drinking Water Standards						
	• UAC R315-101—Cleanup and Risk-based Closure Standards: RCRA, UST, and CERCLA Sites						
3: Enhanced Phytoremediation, MNA, and ICs	• UAC R311-211—Corrective Actions Cleanup Standards Policy—UST and CERCLA Sites	Considered reliable because phytoremediation is passive with minimal potential for remedy failure.	No known toxic residuals from phytoremediation of from biodegradation.	Approximately 1 year	20 years	Capital = \$136,000 O&M = \$1,999,000 Total Present Worth = \$2,135,000	Existing phytoremediation and natural attenuation would restore groundwater to potentially unrestricted use conditions within a reasonable timeframe. Enhanced phytoremediation system also would capture greenhouse gases and improve the aesthetics of the area. ICs expected to prevent exposure to contamination until the RG is achieved.
	• UAC R309-200-5—Monitoring and Water Quality: Drinking Water Standards						
	• UAC R315-101—Cleanup and Risk-based Closure Standards: RCRA, UST, and CERCLA Sites						
4: Groundwater Extraction and Discharge, Existing Phytoremediation, MNA, and ICs	• UAC R311-211—Corrective Actions Cleanup Standards Policy—UST and CERCLA Sites	Generally reliable; however, possibility of performance loss due to biofouling and scaling exists.	No toxic residuals anticipated from groundwater extraction, phytoremediation, or biodegradation.	Approximately 1 year	20 years	Capital = \$900,000 O&M = \$3,505,000 Total Present Worth = \$4,405,000	Groundwater extraction, existing phytoremediation, and natural attenuation would restore groundwater to potentially unrestricted use conditions within a reasonable timeframe. ICs expected to prevent exposure to contamination until the RG is achieved.
	• UAC R309-200-5—Monitoring and Water Quality: Drinking Water Standards						
	• UAC R315-101—Cleanup and Risk-based Closure Standards: RCRA, UST, and CERCLA Sites						
	• UAC R317-8-8—Pretreatment						
5: Enhanced Bioremediation and ICs	• UAC R311-211—Corrective Actions Cleanup Standards Policy—UST and CERCLA Sites	Proposed strategy of treatment is multiple rows of direct-push injections. Enhanced bioremediation has proven successful at other Department of Defense facilities; therefore, remedy would be reliable because it is proven and there would not be extensive construction.	Injection could result in temporary reductive dechlorination daughter products; as well as gaseous by-products (methane), and temporally mobilize naturally occurring metals. Accumulation of TCE daughter products (cis-1,2-dichloroethene, and vinyl chloride) is temporary and daughter products will attenuate. Concentrations of methane and metals will decline once conditions return to aerobic conditions after treatment ceases.	Approximately 1 year	7 years	Capital = \$1,514,000 O&M = \$628,000 Total Present Worth = \$2,157,000	Enhanced bioremediation would restore groundwater to potentially unrestricted use conditions within a reasonable timeframe. ICs expected to prevent exposure to contamination until RGs are achieved.
	• UAC R309-200-5—Monitoring and Water Quality: Drinking Water Standards						
	• UAC R315-101—Cleanup and Risk-based Closure Standards: RCRA, UST, and CERCLA Sites						
	• UAC R317-7—Underground Injection Control Program						

NOTES:
⁽¹⁾ Estimated remedial timeframes and costs are presented in the OU 9 Revised FS Report (CH2M HILL 2010a) and the OU 9 FS Supplement (EA 2014a). Estimated costs are within a -30 to +50 percent accuracy range.
⁽²⁾ Present worth costs were calculated using the following real discount rates: 2.7 percent for Alternatives 2 through 4, and -0.4 percent for Alternative 5. The real discount rates were based on expected remedial timeframes and were obtained from the White House Office of Management and Budget Circular A-94 (http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c/). This is consistent with the guidance for federal facilities in the EPA guidance document, A Guide to Preparing and Documenting Cost Estimates During the FS (EPA 2000).

ARAR = Applicable or Relevant and Appropriate Requirement.
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
EA = EA Engineering, Science, and Technology, Inc., PBC.
EPA = U.S. Environmental Protection Agency.
FS = Feasibility Study.
IC = Institutional control.
MNA = Monitored natural attenuation.
NA = Not applicable.

RCRA = Resource Conservation and Recovery Act.
RG = Remediation goal.
O&M = Operation and maintenance.
OU = Operable Unit.
TCE = Trichloroethene.
UAC = Utah Administrative Code.
UST = Underground storage tank.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 2-15
Distinguishing Features of Remedial Alternatives for Site SS090 (Golf Course Area)
Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Remedial Alternative Name	Key ARARs	Long-Term Reliability of Remedy	Characteristics of Treatment Residuals	Estimated Time Frame of Implementation	Estimated Remediation Time ⁽¹⁾	Estimated Capital, Annual O&M, and Total Present Worth Costs ^{(1) (2)}	Expected Outcomes
1: No Action	• UAC R311-211—Corrective Actions Cleanup Standards Policy—UST and CERCLA Sites	None	NA	NA	NA	Capital = \$0 O&M= \$0 Total Present Worth= \$0	Natural attenuation may restore groundwater to potentially unrestricted use conditions and soil to RGs, but there would be no verification of the remediation.
	• UAC R309-200-5—Monitoring and Water Quality: Drinking Water Standards						
	• UAC R315-101—Cleanup and Risk-based Closure Standards: RCRA, UST, and CERCLA Sites						
2: Oil Shield, MNA, and ICs	• UAC R311-211—Corrective Actions Cleanup Standards Policy—UST and CERCLA Sites	Considered reliable because the remedy would be passive with minimal potential for loss of performance or failure.	Could result in temporary reductive dechlorination daughter products; as well as gaseous by-products (e.g., methane), and temporarily mobilize naturally occurring metals. Accumulation of TCE and PCE daughter products (cis-1,2-dichloroethene, and vinyl chloride) is temporary and daughter products will attenuate. Concentrations of methane and metals will decline once conditions return to aerobic conditions after treatment ceases.	Approximately 1 year	75 years	Capital = \$293,000 O&M = \$1,809,000 Total Present Worth = \$1,516,000	Natural attenuation would reduce concentrations of PCE and TCE in soil beneath the source zone to RGs while the oil shield captures infiltrating contamination. The oil shield also would enhance natural attenuation of the groundwater plumes by serving as a carbon donor. ICs expected to prevent exposure to contamination until RGs are achieved.
	• UAC R309-200-5—Monitoring and Water Quality: Drinking Water Standards						
	• UAC R315-101—Cleanup and Risk-based Closure Standards: RCRA, UST, and CERCLA Sites						
	• UAC R317-7—Underground Injection Control Program						
3: SVE, MNA, and ICs	• UAC R311-211—Corrective Actions Cleanup Standards Policy—UST and CERCLA Sites	Soil vapor extraction is a proven technology and is therefore considered reliable; however, there is some uncertainty about how reliably SVE will remove contamination from the least permeable zones.	Toxic residuals are not anticipated.	Approximately 18 to 24 months for possible pre-design data collection	39 years	Capital = \$594,000 O&M = \$1,798,000 Total Present Worth = \$2,392,000	Soil vapor extraction would remove PCE and TCE from soil beneath the source zone. The silty clay of the source zone may cause uneven treatment, which could be addressed by permeability enhancement if necessary. ICs expected to prevent exposure to contamination until RGs are achieved.
	• UAC R309-200-5—Monitoring and Water Quality: Drinking Water Standards						
	• UAC R315-101—Cleanup and Risk-based Closure Standards: RCRA, UST, and CERCLA Sites						
	• UAC R307-214—NESHAP						
	• UAC R307-410—Documentation of Ambient Air Impacts for Hazardous Air Pollutants						
	• UAC R307-401-15 and 16—Permits: New and Modified Sources—Exemptions and Special Provisions						
4: SVE, In Situ Treatment, MNA, and ICs	• UAC R311-211—Corrective Actions Cleanup Standards Policy—UST and CERCLA Sites	For the unsaturated zone, SVE is a proven technology and therefore is considered reliable; however, there is some uncertainty about how reliably SVE would remove contamination from the least permeable zones. For the saturated zone, an in situ treatability study at OU 10 demonstrated limited distribution through heterogeneous sediment similar to those at Site SS090 (Golf Course Area).	Injection of a chemical oxidant could temporarily mobilize metals. Concentrations of metals will decline once conditions return to background after treatment ceases.	Approximately 18 to 24 months for design and construction of both SVE and in situ treatment systems	31 years	Capital = \$862,000 O&M = \$4,293,000 Total Present Worth = \$5,155,000	In situ treatment is expected to reduce the remedial timeframe of the PCE plume; however, rebound of contamination from the immobile domain could limit the effectiveness of the remedy. ICs are expected to prevent exposure to contamination until RGs are achieved.
	• UAC R309-200-5—Monitoring and Water Quality: Drinking Water						
	• UAC R315-101—Cleanup and Risk-based Closure Standards: RCRA, UST, and CERCLA Sites						
	• UAC R307-214—NESHAP						
	• UAC R307-410—Documentation of Ambient Air Impacts for Hazardous Air Pollutants						
	• UAC R307-401-15 and 16—Permits: New and Modified Sources—Exemptions and Special Provisions						
	• UAC R317-7—Underground Injection Control Program						
5: Groundwater Extraction and Discharge, MNA, and ICs	• UAC R311-211—Corrective Actions Cleanup Standards Policy—UST and CERCLA Sites	Generally reliable; however, possibility of performance loss due to biofouling and scaling exists.	Toxic residuals are not anticipated.	Approximately 1 year	75 years	Capital = \$1,703,000 O&M = \$5,127,000 Total Present Worth = \$6,830,000	Groundwater extraction would hydraulically contain an area of relatively high groundwater contaminant concentrations beneath the source zone, but would have to operate for the predicted period required for dissipation of contamination from the source zone. ICs are expected to prevent exposure to contamination until RGs are achieved.
	• UAC R309-200-5—Monitoring and Water Quality: Drinking Water Standards						
	• UAC R315-101—Cleanup and Risk-based Closure Standards: RCRA, UST, and CERCLA Sites						
	• UAC R317-8-8—Pretreatment						

TABLE 2-15
Distinguishing Features of Remedial Alternatives for Site SS090 (Golf Course Area)
Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Remedial Alternative Name	Key ARARs	Long-Term Reliability of Remedy	Characteristics of Treatment Residuals	Estimated Time Frame of Implementation	Estimated Remediation Time ⁽¹⁾	Estimated Capital, Annual O&M, and Total Present Worth Costs ^{(1) (2)}	Expected Outcomes
6: Excavation, MNA, and ICs	• UAC R311-211—Corrective Actions Cleanup Standards Policy—UST and CERCLA Sites	Considered reliable because there would be no remedial system to operate after excavation.	Toxic residuals are not anticipated.	Approximately 1 year	38 years	Capital = \$6,691,000 O&M = \$1,472,000 Total Present Worth = \$8,163,000	Excavation of source zone soil would reduce the remediation time of PCE and TCE in groundwater. ICs are expected to prevent exposure to contamination until RGs are achieved.
	• UAC R309-200-5—Monitoring and Water Quality: Drinking Water Standards						
	• UAC R315-101—Cleanup and Risk-based Closure Standards: RCRA, UST, and CERCLA Sites						
	• UAC R315-13—Land Disposal Restrictions						
	• UAC R307-205-3,5—Fugitive Dust Control Requirements for Construction and Demolition Activities						
	• UAC R307-309-6—Nonattainment and Maintenance Areas for PM ₁₀ and PM _{2.5} : Fugitive Emissions and Fugitive Dust						
	• 40 CFR 300.440—CERCLA Offsite Rule						
7: SVE, Phytoremediation, MNA, and ICs	• UAC R311-211—Corrective Actions Cleanup Standards Policy—UST and CERCLA Sites	There is some uncertainty about how reliably SVE would remove contamination from the least permeable zones. Performance of trees with engineered deep rooting systems also is uncertain.	Toxic residuals are not anticipated.	Approximately 18 to 24 months for possible pre-design data collection for the SVE system.	30 years	Capital = \$955,000 O&M = \$2,303,000 Total Present Worth = \$3,258,000	SVE would remediate PCE and TCE in soil. The silty clay of the source zone may cause uneven treatment. Phytoremediation could reduce the remedial time of PCE in groundwater if the engineered deep rooting systems remain healthy. ICs are expected to prevent exposure to contamination until RGs are achieved.
	• UAC R309-200-5—Monitoring and Water Quality: Drinking Water Standards						
	• UAC R315-101—Cleanup and Risk-based Closure Standards: RCRA, UST, and CERCLA Sites						
	• UAC R307-214—NESHAP						
	• UAC R307-410—Documentation of Ambient Air Impacts for Hazardous Air Pollutants						
	• UAC R307-401-15 and 16—Permits: New and Modified Sources—Exemptions and Special Provisions						
8: Limited Excavation, Enhanced Bioremediation, MNA, and ICs	• UAC R311-211—Corrective Actions Cleanup Standards Policy—UST and CERCLA Sites	The bioreactor approach is considered more reliable than SVE or GED because it provides treatment of PCE and TCE in the unsaturated and saturated zones in the source area. Enhanced bioremediation through carbon substrate injections has been tested at OU 2 and OU 10 at Hill AFB. Natural attenuation also has been demonstrated for the groundwater contaminants at Site SS090 (CH2M HILL 2010a). Therefore, the remedy would be reliable.	Enhanced bioremediation could result in temporary reductive dechlorination daughter products; as well as gaseous by-products (e.g., methane), and temporarily mobilize naturally occurring metals. Accumulation of TCE and PCE daughter products (cis-1,2-dichloroethene, and vinyl chloride) is temporary and daughter products will attenuate. Concentrations of methane and metals will decline once conditions return to aerobic conditions after treatment ceases.	Approximately 1 year	31 years	Capital = \$1,455,000 O&M = \$1,125,000 Total Present Worth = \$2,440,000	Limited excavation, enhanced bioremediation, and natural attenuation would restore groundwater to potentially unrestricted use conditions within a reasonable timeframe. ICs are expected to prevent exposure to contamination until RGs are achieved.
	• UAC R309-200-5—Monitoring and Water Quality: Drinking Water Standards						
	• UAC R315-101—Cleanup and Risk-based Closure Standards: RCRA, UST, and CERCLA Sites						
	• UAC R317-7—Underground Injection Control Program						
	• UAC R315-13—Land Disposal Restrictions						
	• UAC R307-205-3,5—Fugitive Dust Control Requirements for Construction and Demolition Activities						
	• UAC R307-309-6—Nonattainment and Maintenance Areas for PM ₁₀ and PM _{2.5} : Fugitive Emissions and Fugitive Dust						

NOTES:
⁽¹⁾ Estimated remedial timeframes and costs are presented in the OU 9 Revised FS Report (CH2M HILL 2010a) and the OU 9 FS Supplement (EA 2014a). Estimated costs are within a -30 to +50 percent accuracy range.
⁽²⁾ Present worth costs were calculated using the following real discount rates: 2.7 percent for Alternatives 2 through 7, and 1.1 percent for Alternative 8. The real discount rates were based on expected remedial timeframes and were obtained from the White House Office of Management and Budget Circular A-94 (http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c/). This is consistent with the guidance for federal facilities in the EPA guidance document, A Guide to Preparing and Documenting Cost Estimates During the FS (EPA 2000).

AFB = Air Force Base.
ARAR = Applicable or Relevant and Appropriate Requirement.
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
EA = EA Engineering, Science, and Technology, Inc., PBC.
EPA = U.S. Environmental Protection Agency.
FS = Feasibility Study.
GED = Groundwater extraction and direct discharge.
IC = Institutional control.
MNA = Monitored natural attenuation.
NA = Not applicable.
NESHAP = National Emission Standards for Hazardous Air Pollutants.

OU = Operable Unit.
O&M = Operation and maintenance.
PCE = Tetrachloroethene.
PM_{2.5} = Particulate matter less than 2.5 micrometers in diameter.
PM₁₀ = Particulate matter less than 10 micrometers in diameter.
RCRA = Resource Conservation and Recovery Act.
RG = Remediation goal.
SVE = Soil vapor extraction.
TCE = Trichloroethene.
UAC = Utah Administrative Code.
UST = Underground storage tank.

TABLE 2-16

Site SS108 (800/900 Area) Alternative Comparison

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Criterion	Alternative 1: No Action	Alternative 2: MNA and ICs
Overall Protection of Human Health and the Environment	Not protective	Protective
Compliance with ARARs	Not compliant	Compliant
Long-Term Effectiveness	Not evaluated	Good
Reduction of TMV	Not evaluated	Fair ⁽³⁾
Short-Term Effectiveness	Not evaluated	Good
Implementability	Not evaluated	Good
Total Life-Cycle Present-Worth Cost ⁽¹⁾	\$0 ⁽²⁾	\$121,000 ⁽⁴⁾
Remedial Timeframe ⁽¹⁾	Not evaluated	2 years

NOTES:

⁽¹⁾ Estimated costs and remedial timeframes are presented in the OU 9 Revised FS Report (CH2M HILL 2010a) and the OU 9 FS Supplement (EA 2014a). Estimated costs are within a -30 to +50 percent accuracy range.

⁽²⁾ In accordance with EPA guidance, the cost associated with the No Action Alternative is presented as \$0.

⁽³⁾ No treatment is planned. However, MNA will show that reduction in TMV has been achieved through natural processes; therefore, no treatment is required.

⁽⁴⁾ The present worth cost for Alternative 2 was calculated using a -1.4 percent real discount rate based on the remedial timeframe and the White House Office of Management and Budget Circular A-94 (http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c/). This is consistent with the guidance for federal facilities in the EPA guidance document, A Guide to Preparing and Documenting Cost Estimates During the FS (EPA 2000).

ARAR = Applicable or relevant and appropriate requirement.

EA = EA Engineering, Science, and Technology, Inc., PBC.

EPA = U.S. Environmental Protection Agency.

FS = Feasibility Study.

IC = Institutional control.

MNA = Monitored natural attenuation.

OU = Operable Unit.

TMV = Toxicity, mobility, or volume.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 2-17

Site SS089 (1100 Area) Alternative Comparison

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Criterion	Alternative 1: No Action	Alternative 2: Existing Phytoremediation, MNA, ICs	Alternative 3: Enhanced Phytoremediation, MNA, ICs	Alternative 4: GED, Existing Phytoremediation, MNA, ICs	Alternative 5: Enhanced Bioremediation, ICs
Overall Protection of Human Health and the Environment	Not protective	Protective	Protective	Protective	Protective
Compliance with ARARs	Not compliant	Compliant	Compliant	Compliant	Compliant
Long-Term Effectiveness	Not evaluated	Good	Good	Good	Good
Reduction of TMV	Not evaluated	Good	Good	Good	Good
Short-Term Effectiveness	Not evaluated	Good	Good	Fair	Good
Implementability	Not evaluated	Good	Good	Fair	Fair
Total Life-Cycle Present-Worth Cost ^{(1) (2)}	\$0 ⁽³⁾	\$1,130,725	\$2,134,759	\$4,405,008	\$2,157,000
Remedial Timeframe ⁽¹⁾	Not evaluated	24 years	20 years	20 years	7 years

NOTES:

⁽¹⁾ Estimated remedial timeframes and costs are presented in the OU 9 Revised FS Report (CH2M HILL 2010a) and the OU 9 FS Supplement (EA 2014a).

Estimated costs are within a -30 to +50 percent accuracy range.

⁽²⁾ Present worth costs were calculated using the following real discount rates: 2.7 percent for Alternatives 2 through 4, and -0.4 percent for Alternative 5. The real discount rates were based on expected remedial timeframes and were obtained from the White House Office of Management and Budget Circular A-94 (http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c/). This is consistent with the guidance for federal facilities in the EPA guidance document, A Guide to Preparing and Documenting Cost Estimates During the FS (EPA 2000).

⁽³⁾ In accordance with EPA guidance, the cost associated with the No Action Alternative is presented as \$0.

ARAR = Applicable or relevant and appropriate requirement.

EA = EA Engineering, Science, and Technology, Inc., PBC.

EPA = U.S. Environmental Protection Agency.

FS = Feasibility Study.

GED = Groundwater extraction and direct discharge.

IC = Institutional control.

MNA = Monitored natural attenuation.

TMV = Toxicity, mobility, or volume.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 2-18
Site SS090 (Golf Course Area) Alternative Comparison
Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Criterion	Alternative 1: No Action	Alternative 2: Oil Shield, MNA, ICs	Alternative 3: SVE, MNA, ICs	Alternative 4: SVE, In Situ Treatment, MNA, ICs	Alternative 5: GED, MNA, ICs	Alternative 6: Excavation, MNA, ICs	Alternative 7: SVE, Phytoremediation, MNA, ICs	Alternative 8: Limited Excavation, Enhanced Bioremediation, MNA, ICs
Overall Protection of Human Health and the Environment	Not protective	Protective	Protective	Protective	Protective	Protective	Protective	Protective
Compliance with ARARs	Not compliant	Compliant	Compliant	Compliant	Compliant	Compliant	Compliant	Compliant
Long-Term Effectiveness	Not evaluated	Good	Good	Good	Good	Good	Good	Good
Reduction of TMV	Not evaluated	Fair	Good	Good	Fair	Good	Good	Good
Short-Term Effectiveness	Not evaluated	Fair	Good	Fair	Poor	Fair	Good	Fair
Implementability	Not evaluated	Good	Good	Good	Fair	Good	Good	Good
Total Life-Cycle Present-Worth Cost ^{(1) (2)}	\$0 ⁽³⁾	\$1,808,979	\$2,391,878	\$5,154,835	\$6,830,304	\$8,162,549	\$3,257,664	\$2,440,000
Remedial Timeframe ⁽¹⁾	Not evaluated	75 years PCE	39 years PCE	31 years PCE	75 years PCE	38 years PCE	30 years PCE	31 years PCE
		17 years TCE	17 years TCE	17 years TCE	17 years TCE	17 years TCE	17 years TCE	17 years TCE

NOTES:
(1) Estimated remedial timeframes and costs are presented in the OU 9 Revised FS Report (CH2M HILL 2010a) and the OU 9 FS Supplement (EA 2014a). Estimated costs are within a -30 to +50 percent accuracy range.
(2) Present worth costs were calculated using the following real discount rates: 2.7 percent for Alternatives 2 through 7, and 1.1 percent for Alternative 8. The real discount rates were based on expected remedial timeframes and were obtained from the White House Office of Management and Budget Circular A-94 (http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c/). This is consistent with the guidance for federal facilities in the EPA guidance document, A Guide to Preparing and Documenting Cost Estimates During the FS (EPA 2000).
(3) In accordance with EPA guidance, the cost associated with the No Action Alternative is presented as \$0.

ARAR = Applicable or relevant and appropriate requirement.
EA = EA Engineering, Science, and Technology, Inc., PBC.
EPA = U.S. Environmental Protection Agency.
FS = Feasibility Study.
GED = Groundwater extraction and direct discharge.
IC = Institutional control.
MNA = Monitored natural attenuation.
OU = Operable Unit.
PCE = Tetrachloroethene.
SVE = Soil vapor extraction.
TCE = Trichloroethene.
TMV = Toxicity, mobility, or volume.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE 2-19
Summary of Applicable or Relevant and Appropriate Requirements for Selected Remedies
Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Citation	ARAR Category	Applicable Remedy			Requirement/Purpose	Applicable or Relevant and Appropriate	Applicability
		Site SS108 (800/900 Area)	Site SS089 (1100 Area)	Site SS090 (Golf Course Area)			
Federal Regulations							
Air Regulations							
Clean Air Act Regulations including Control of Emissions from New and In-Use Non-Road Compression Ignition Engines, 40 CFR 89 (most engines), 40 CFR 90 (at or below 19 kilowatts, 40 CFR 1039 (greater than 19 kilowatts)) General Compliance Provisions for Highway, Stationary, and Non-road Programs 40 CFR 1068	Action-specific		X	X	Establishes requirements for controlling emissions from non-road, compression-ignition engines, and sets certification and exhaust emissions testing requirements.	Applicable	Potentially applicable if remedy component includes regulated engines, such as those associated with construction equipment and drill rigs. The remedial design for the 1100 Area and the Golf Course Area will require that regulated engines used at the site be certified under the EPA's certification program and pass exhaust emissions standards.
Water Regulations							
Federal Safe Drinking Water MCLs; 40 CFR 141 Subpart G	Chemical-specific	X	X	X	Establishes health-based standards (MCLs) for specific organic and inorganic substances to protect drinking water quality. The COCs and associated MCLs are: CT = 0.005 mg/L, TCE = 0.005 mg/L, and PCE = 0.005 mg/L.	Relevant and Appropriate	The selected remedies will comply by reduction of contaminants through treatment or natural attenuation that will allow the MCLs to be met.
Solid and Hazardous Waste Regulations							
Identification and Listing of Hazardous Waste – 40 CFR 261.24	Action-specific			X	Defines solid waste that is subject to regulation as hazardous waste including the toxicity characteristic for hazardous waste (using TCLP analyses).	Applicable	The selected remedy will comply by analyzing excavated soil, drill cuttings, and other contaminated media. If wastes are found to be hazardous, waste will be containerized, transported, and disposed in accordance with applicable regulations.
Standards Applicable to Generators of Hazardous Waste – 40 CFR 262	Action-specific			X	Specifies standards for management of hazardous waste by hazardous waste generators, including management in tanks and containers.	Applicable	The selected remedy will comply by ensuring that containerized waste (excavated soil, drill cuttings, and other contaminated media) determined to be hazardous are properly labeled, stored, and inspected; staff is appropriately trained; and spill prevention and response procedures are in place.
Land Disposal Restrictions – 40 CFR Part 268	Action-specific			X	Sets concentration limits for hazardous wastes that are restricted from land disposal.	Applicable	The hazardous waste program has been delegated to the State of Utah, whose requirements are at least as stringent as federal ones.
Contained-in Policy (63 Federal Register 28618–28620; May 26, 1998) Management of Soils Containing Hazardous Waste	Action-specific			X	Contaminated media, of itself, is not hazardous waste. However, contaminated environmental media can be subject to regulation under RCRA if it “contains” hazardous waste (i.e., contains levels of contaminants that are above the waste criteria, or is contaminated with a listed hazardous waste [listed wastes are found in 40 CFR 261.24, see above]). TCE and PCE are on the hazardous waste TCLP list and have been detected in soils and groundwater.	TBC	Excavated soil will be tested to determine if it would be subject to this policy. Existing contamination is not believed to be from sources that include listed hazardous wastes.
Hazardous Materials Transportation Act, Sections within 49 CFR Parts 171-173 and 177 pertaining to labeling and containerization of hazardous wastes	Action-specific			X	Established standards for packaging, labeling, and transporting hazardous materials (which include hazardous wastes).	Relevant and Appropriate	Relevant and appropriate, if hazardous materials are encountered and transported offsite. Offsite hazardous waste transportation is regulated through RCRA authorities rather than CERCLA ARARs.
State of Utah Regulations							
Air Regulations							
UAC R307-205-3, 5—Fugitive Dust Control Requirements for Construction and Demolition Activities	Action-specific		X	X	Preventative measures must be taken to minimize fugitive dust for materials handling operations (e.g., gravel for well packs) and for construction/demolition that disturbs more than 0.25 acre. This includes fugitive dust/dirt that is tracked out from the construction site to public or private paved roads.	Applicable	Applicable to remedy components that may require soil disturbance, such as drilling, land clearing, or soil excavation activities. Fugitive dust prevention measures will be taken during remediation at the Golf Course Area.
UAC R307-309-5, 6— General Requirements for Fugitive Dust and Non-attainment and Maintenance Areas for PM ₁₀ and PM _{2.5} : Fugitive Emissions and Fugitive Dust	Action-specific			X	Fugitive Dust Control Plans must be prepared for all actions disturbing 0.25 acre or more within PM _{2.5} non-attainment areas.	Applicable	Hill AFB is in a non-attainment area for PM _{2.5} at this time. Fugitive dust requirements are relevant and appropriate for alternatives that may create dust, such as excavation. A fugitive dust control plan will be prepared for remedial actions at Golf Course Area, if needed.
UAC R307-325—Ozone Non-attainment and Maintenance Areas: General Requirements	Action-specific			X	No person shall allow or cause VOCs to be spilled, discarded, stored in open containers, or handled in any other manner that would result in greater evaporation of VOCs than would have if RACT had been applied.	Applicable	Applicable to remedy components that disturb VOC-containing media, such as soil excavation at the Golf Course Area.

TABLE 2-19
Summary of Applicable or Relevant and Appropriate Requirements for Selected Remedies
Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Citation	ARAR Category	Applicable Remedy			Requirement/Purpose	Applicable or Relevant and Appropriate	Applicability
		Site SS108 (800/900 Area)	Site SS089 (1100 Area)	Site SS090 (Golf Course Area)			
Water Regulations							
UAC R317-7—UIC Program	Action-specific		X	X	Injection wells need to be authorized by the state. Prohibits wells that inject hazardous, radioactive, mining, and municipal waste fluids into any underground source of drinking water or exempted aquifer; requires any new injection well to be sited beyond an area that extends at least 2 miles from any part of a drinking water source; requires grouting or some other acceptable technique to preserve the integrity of the confining zone or zones when undesirable mixing of fluids occurs due to improper well construction or use of an injection well; requires inspection, monitoring, and recordkeeping activities.	Applicable	Applicable for remedial alternatives that require injections of carbon substrate for enhanced bioremediation, such as 1100 Area and Golf Course Area. Injection wells that would be used in remedial alternatives, would likely be classified as Beneficial Use Wells, Underground Injection Control Class 5 wells, by the Utah Division of Water Quality. This class of wells requires a less stringent permitting process than other well classes. However, since permitting requirements are administrative requirements, they would not apply to remedial actions taken onsite, under the CERCLA Section 121 permit exclusion. If an injection well is proposed, state design and operating requirements should be followed. Requirements for Class 5 injection wells include: <ul style="list-style-type: none">Information submitted to the UDEQ for the injection well inventoryInjection well will be properly operated and maintainedCalibration, injection, and other records will be maintained for 3 years after abandonment of injection wellClose the well properly so that fluids cannot move into a drinking water aquifer.
UAC R317-8-7—UPDES, specifically R317-8-2.5(1)(b) and 3,9(6)(d)(10)	Action-specific			X	The UPDES program requires permits for discharge of pollutants from any point source into waters of the state. Construction stormwater permit requirements have specific actions that should be taken to minimize the impact of a construction site on surface water; these requirements apply to areas where more than 1 acre of soil is disturbed.	Applicable	Excavation of soil at the Golf Course Area may disturb more than 1 acre of soil. Substantive requirements of the Construction Stormwater Permit (UTR300000), including implementing best management practices to prevent discharge of pollutants (such as sediment) to stormwater, preparation of a SWPPP, and sampling as required by R317-8-3.9. These requirements would be applicable for remedial alternatives disturbing more than 1 acre of land. If less than 1 acre is disturbed, then the construction stormwater requirements are relevant and appropriate. However, since permitting requirements are administrative requirements, they would not apply to remedial actions taken onsite, under the CERCLA Section 121 permit exclusion.
UAC R317-8-8—UPDES, POTW Pre-treatment Requirements	Action-specific	X	X	X	Requires discharges to Publically Owned Treatment Works (POTWs, as defined in R317-8-8) (i.e., sewage treatment plants owned by municipalities) to meet certain discharge requirements.	Applicable	Aqueous wastes from the sites (e.g., well development and purge water, decontamination water) will be discharged to the Hill AFB Industrial Waste Treatment Plant (IWTP), which eventually discharges to a POTW. Discharges to the IWTP must be characterized and coordinated with IWTP managers prior to discharge. Aqueous wastes may be treated (e.g., with carbon) if required by the IWTP managers. If the wastewater cannot go to the IWTP, it will be disposed offsite to a disposal facility permitted to manage wastewater appropriately. The pre-treatment standards/requirements specified in the POTW discharge permit will be met prior to any discharge to the IWTP. Discharges to the IWTP will meet the following daily maximum values specified in the Central Weber Sewer Improvement District Industrial Wastewater Discharge Permit for the IWTP: <ul style="list-style-type: none">VOC: 2.13 mg/LLead: 1.14 mg/LNickel: 4.10 mg/LZinc: 4.57 mg/LpH: minimum 5.0 and maximum 11.0
UAC R309-200-5—Monitoring and Water Quality: Drinking Water	Chemical-specific	X	X	X	Establishes primary MCLs for inorganic and organic chemicals including TCE, PCE, and CT.	Relevant and Appropriate	MCLs are applicable to proposed remedial alternatives since the RGs for groundwater at the OU 9 areas are based on these MCLs. The MCLs for the COCs for all three OU 9 sites include: <ul style="list-style-type: none">TCE: MCL = 5 µg/LPCE: MCL = 5 µg/LCT: MCL = 5 µg/L.

TABLE 2-19
Summary of Applicable or Relevant and Appropriate Requirements for Selected Remedies
Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Citation	ARAR Category	Applicable Remedy			Requirement/Purpose	Applicable or Relevant and Appropriate	Applicability
		Site SS108 (800/900 Area)	Site SS089 (1100 Area)	Site SS090 (Golf Course Area)			
UAC R317-6—Environmental Quality and Water Quality; Groundwater Protection	Chemical-specific	X	X	X	Establishes groundwater quality standards (R317-6-2), groundwater classes (R317-6-3), and groundwater class protection levels (R317-6-4). Groundwater quality standards (R317-6-2) are applicable corrective action cleanup levels for contaminated ground water under R317-6-6.15F. The standards are the same as primary drinking water standards for the COCs at this site (i.e., MCLs). ACACLs can be established pursuant to R317-6-6.15. Groundwater class protection levels (R317-6-4) are not intended to be used as ARARs under CERCLA.	Applicable	Applicable to any remedy that affects groundwater quality. The remedial goals for the three sites are the MCLs for the COCs.
Environmental Response and Remediation							
UAC R311-211—Corrective Action Cleanup Standards Policy, UST and CERCLA Sites							
UAC R311-211-2—Source Elimination	Action-specific			X	The initial step in corrective actions implemented at CERCLA sites is to take appropriate action to eliminate the source of contamination through either removal or appropriate source control.	Applicable	No source areas were found at the 800/900 Area and the 1100 Area during the investigation. The Golf Course source area will be addressed by excavating contaminated soil in the unsaturated zone and replacing with certified clean fill mixed with carbon substrate. The groundwater recirculation system will enhance bioremediation of the contaminated soil and groundwater remaining in the source zone.
UAC R311-211-4—Prevention of Further Degradation	Action-specific	X	X	X	Provides general criteria to be considered in prevention of further degradation.	Applicable	The selected remedies will employ source treatment (Golf Course Area), in situ treatment (1100 Area; Golf Course Area), or MNA (800/900 Area, Golf Course Area) to prevent further degradation of groundwater.
UAC R311-211-5—Cleanup Standards	Action-specific Chemical-specific	X	X	X	Establishes minimum cleanup standards for UST or CERCLA sites. Federal drinking water MCLs are incorporated by UAC R311-211-5 as minimum cleanup levels for water-related contamination. Soil cleanup levels for protection of groundwater quality should be based on MCLs or other appropriate standards.	Applicable	The MCLs for CT, TCE, and PCE are the RGs for groundwater for all three sites. The TCE and PCE RG for Golf Course Area soil is based on the MCL-based screening levels for the protection of groundwater derived from the EPA RSL table times an assumed dilution attenuation factor of 20; the soil RG is lower than the soil RSLs for residential exposure. Proposed remedial actions will achieve these RGs.
Solid and Hazardous Waste Regulations							
UAC R315-1—Hazardous Waste Definitions	Action-specific Chemical-specific			X	Provides definitions and defines how to determine whether a waste is a hazardous waste.	Applicable	Wastes generated will be characterized to determine if they are hazardous wastes.
UAC R315-2—General Requirements, Identification, and Listing of Hazardous Waste	Action-specific Chemical-specific			X	As discussed in R315-5-1.11, a generator is required to characterize waste in accordance with the standards specified in R315-2. A waste is considered a RCRA hazardous waste if it exhibits any characteristic of ignitability, corrosivity, reactivity, or toxicity, or if it is listed as a hazardous waste. Most waste determinations will focus on whether the generated waste (e.g., treatment residuals) could be classified as toxicity characteristic waste as defined by the contaminant concentrations (e.g., a D-code hazardous waste). The toxicity characteristic is determined by TCLP analysis on representative waste samples.	Applicable	Wastes generated during construction, monitoring, or remediation will be characterized and managed in accordance with UAC R315 requirements. Potential hazardous wastes include, but are not limited to, drill cuttings from well installation, excavated contaminated soil, and contaminated groundwater extracted for treatment. The building associated with the site was in use from 1943 through 1971, before the effective date of RCRA. The source of the TCE contamination at SS090 (Golf Course Area) is not documented. According to EPA guidance if “documentation regarding a source of contamination, contaminant, or waste is unavailable or inconclusive...one may assume the source, contaminant or waste is not listed hazardous waste” (Management of Remediation Waste Under RCRA, EPA530-F-98-026, October 1998). Therefore, wastes are not listed hazardous waste and will be analyzed using TCLP to characterize the waste and determine if the waste is hazardous. Utah adopts federal rules and TCLP levels for classifying waste as hazardous waste by toxicity characteristic.
UAC R315-5— Hazardous Waste Generator Requirements (adopts 40 CFR 262)	Action-specific			X	Establishes standards for generators of hazardous waste. If waste is stored in containers for longer than 90 days, then the substantive requirements of UAC R315-8 for container storage would be applicable.	Applicable	The selected remedy will comply by ensuring that containerized waste (drill cuttings and other contaminated media) determined to be hazardous are properly labeled, stored, and inspected; staff is trained appropriately; and spill prevention and response procedures are in place.
UAC R315-5-3.34—Hazardous Waste Accumulation (adopts 40 CFR 262.34)	Action-specific			X	Establishes requirements for temporary hazardous waste storage in tanks and containers for less than 90 days. Specific requirements are discussed in the regulations, including labeling, management, training, preparedness and prevention, emergency response, and others.	Applicable	Potential hazardous wastes include, but are not limited to, drill cuttings from well installation, excavated contaminated soil, and contaminated groundwater extracted for treatment. Containers of hazardous waste must: <ul style="list-style-type: none">• Be maintained in good condition• Be compatible with hazardous waste to be stored• Be closed during storage except to add or remove waste• Have adequate secondary containment when stored onsite• Be marked with “hazardous waste” or other words identifying contents.

TABLE 2-19
Summary of Applicable or Relevant and Appropriate Requirements for Selected Remedies
Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Citation	ARAR Category	Applicable Remedy			Requirement/Purpose	Applicable or Relevant and Appropriate	Applicability
		Site SS108 (800/900 Area)	Site SS089 (1100 Area)	Site SS090 (Golf Course Area)			
UAC R315-8—Standards for Owners and/or Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	Action-specific			X	Describes the general requirements that must be implemented at hazardous waste treatment, storage, and disposal facilities, where hazardous wastes are stored for more than 90 days. Addresses closure of hazardous waste units, including removal of wastes at closure, post closure care, including putting a notice in deed if contamination is left in place.	Relevant and Appropriate	Accumulation of hazardous wastes onsite for longer than 90 days would be subject to RCRA requirements for storage facilities. Although no permit is required, storage of hazardous wastes for longer than 90 days must meet the substantive requirements for hazardous waste storage facilities. The substantive management standards include: <ul style="list-style-type: none">Contingency plan and emergency proceduresPreparedness and preventionTraining planWaste analysis planProfessional Engineer certification of tanksInspection of tanks and containers. It is expected that hazardous waste generated would be disposed within 90 days. Closure standards will be met at the site by excavating soil at SS090, implementing long-term monitoring to document MNA, and implementing institutional controls similar to the RCRA notice-in-deed.
UAC R315-9—Emergency Controls	Action-specific			X	Outlines requirements for emergency controls of hazardous waste spills, including immediate action, cleanup, and reporting.	Applicable	Applicable if hazardous wastes are spilled.
UAC R315-13—LDRs	Action-specific			X	Identifies hazardous waste that is restricted from land disposal through adoption of federal requirements as found in 40 CFR 268. LDRs are applicable if waste or excavated soil that fails a hazardous waste characteristic is placed back into the area of concern. The enhanced bioremediation activities at the Golf Course will comply with LDRs and other RCRA requirements for waste classification and handling.	Applicable	Applicable to hazardous waste that is land disposed. 40 CFR 268.49 allows for an alternative LDR for soil (90 percent reduction in concentration or 10 times the non-wastewater LDR). LDR treatment standards for COCs at OU 9 Golf Course Area include: <ul style="list-style-type: none">TCE: Wastewater = 0.054 mg/L (40 CFR 268.48); Non-wastewater (e.g., sludge, solids) = 6.0 mg/kg (40 CFR 268.48); Soil = 60 mg/kg (40 CFR 268.49)PCE: Wastewater = 0.056 mg/L; Non-wastewater = 6.0 mg/kg; Soil = 60 mg/kg (40 CFR 268.49). If wastes generated are characteristic hazardous wastes (e.g., fail TCLP, then the wastes also must be treated to the LDRs for both the hazardous waste characteristic and for any UHCs that may be present before the waste can be land disposed. UHCs are constituents above their LDR concentration found in the UTS list in 40 CFR 268.48.
UAC R315-101—Environmental Quality: Cleanup Actions and Risk-Based Closure Standards	Action-specific	X	X	X	UAC R315-101 establishes requirements to support risk-based cleanup and closure standards at sites for which remediation or removal of hazardous constituents to background levels will not be achieved. Requires removal or control of the source and non-degradation beyond existing contaminant levels.	Applicable	No source areas were found at the 800/900 Area and the 1100 Area during the investigation. The Golf Course source area will be addressed by excavating contaminated soil in the unsaturated zone and replacing it with certified clean fill mixed with carbon substrate. The groundwater recirculation system will enhance bioremediation of the contaminated soil and groundwater remaining in the source zone.
UAC R315-101-2—Stabilization							
UAC R315-101-3—Principle of Non-degradation	Action-specific	X	X	X	Contamination levels cannot be allowed to increase.	Applicable	Proposed remedial actions at all three sites will prevent further degradation of groundwater.
UAC R315-101-6—Site Management Plan and Closure Equivalency	Action-specific	X	X	X	Describes procedures to follow and required plans to remediate a site.	Applicable	The procedures, documents, and public participation requirements of the NCP meet these requirements for all three sites.
UAC R315-101-7—Public Participation							
UAC R315-101-8—Cleanup/Management Action							
Water Rights							
UAC R655-4-12,13,14,15—Monitoring Well Construction Standards	Action-specific	X	X	X	Established standards and requirements for drilling and abandonment of wells, including monitoring wells.	Applicable	Applicable to alternatives that require the installation of treatment and/or monitoring wells. All injection and monitoring wells will be constructed to these standards.

TABLE 2-19
Summary of Applicable or Relevant and Appropriate Requirements for Selected Remedies
Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Citation	ARAR Category	Applicable Remedy			Requirement/Purpose	Applicable or Relevant and Appropriate	Applicability
		Site SS108 (800/900 Area)	Site SS089 (1100 Area)	Site SS090 (Golf Course Area)			

NOTES:

µg/L = Microgram(s) per liter.
ACACL = Alternate corrective action concentration limit.
AFB = Air Force Base.
ARAR = Applicable or Relevant and Appropriate Requirement.
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
CFR = Code of Federal Regulations.
COC = Contaminant of concern.
CT = Carbon tetrachloride.
EPA = U.S. Environmental Protection Agency.
IWTP = Industrial Waste Treatment Plant.
LDR = Land disposal restriction.
MCL = Maximum Contaminant Level.
mg/kg = Milligram(s) per kilogram.
mg/L = Milligram(s) per liter.
MNA = Monitored natural attenuation.
NCP = National Contingency Plan.
OU = Operable Unit.
PCE = Tetrachloroethene.
PM_{2.5} = Particulate matter less than 2.5 micrometers in diameter.

PM₁₀ = Particulate matter less than 10 micrometers in diameter.
POTW = Publically Owned Treatment Work.
RACT = Reasonably available control technology.
RCRA = Resource Conservation and Recovery Act.
RG = Remediation goal.
ROD = Record of Decision.
RSL = Regional Screening Level.
SWPPP = Stormwater Pollution Prevention Plan.
TBC = To be considered.
TCE = Trichloroethene.
TCLP = Toxicity Characteristic Leaching Procedure.
UAC = Utah Administrative Code.
UDEQ = Utah Department of Environmental Quality.
UHC = Underlying hazardous constituents.
UIC = Underground Injection Control.
UPDES = Utah Pollutant Discharge Elimination System.
UST = Underground storage tank.
UTS = Universal Treatment Standards.
VOC = Volatile organic compound.

THIS PAGE INTENTIONALLY LEFT BLANK

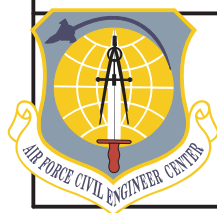
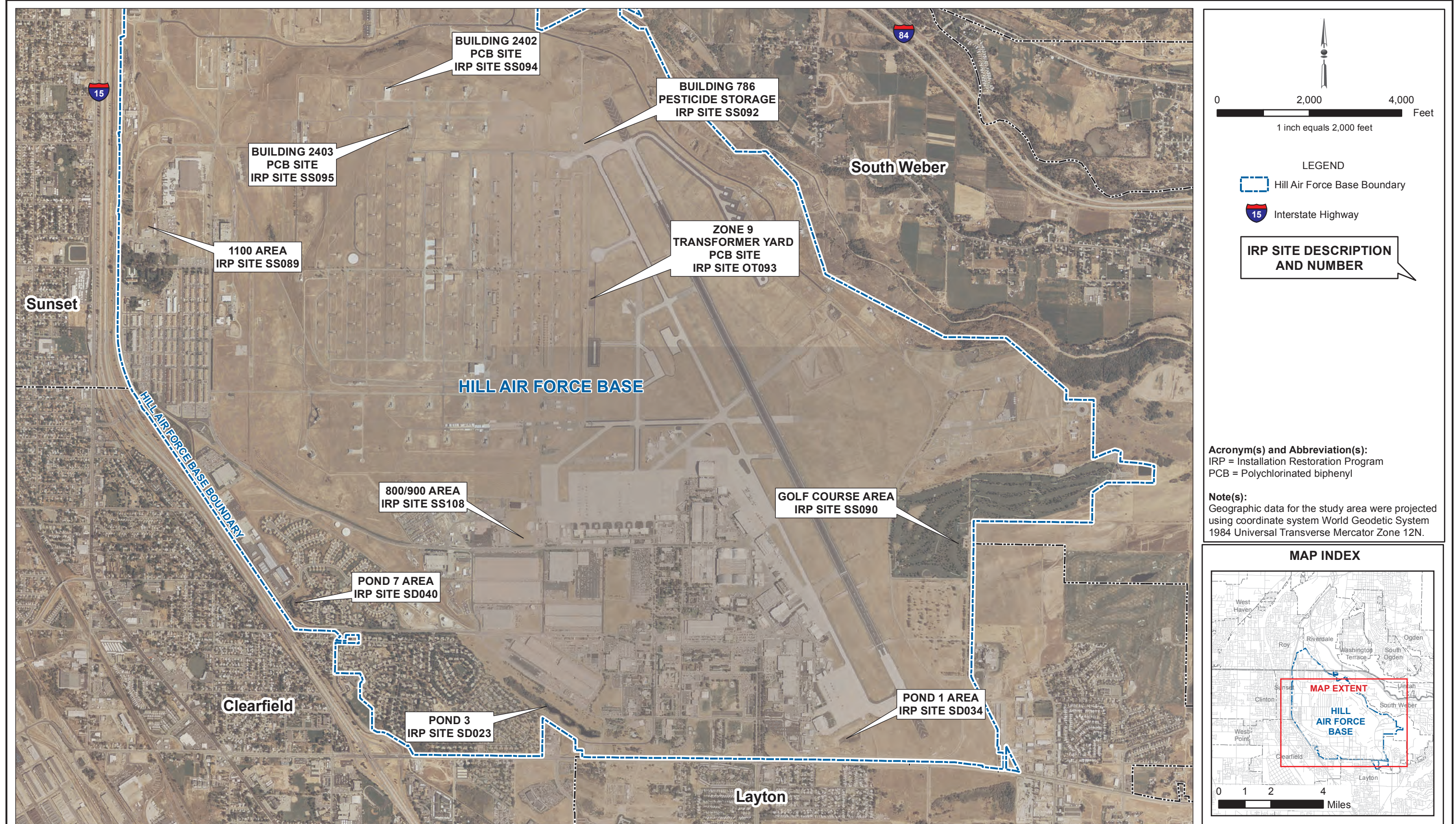
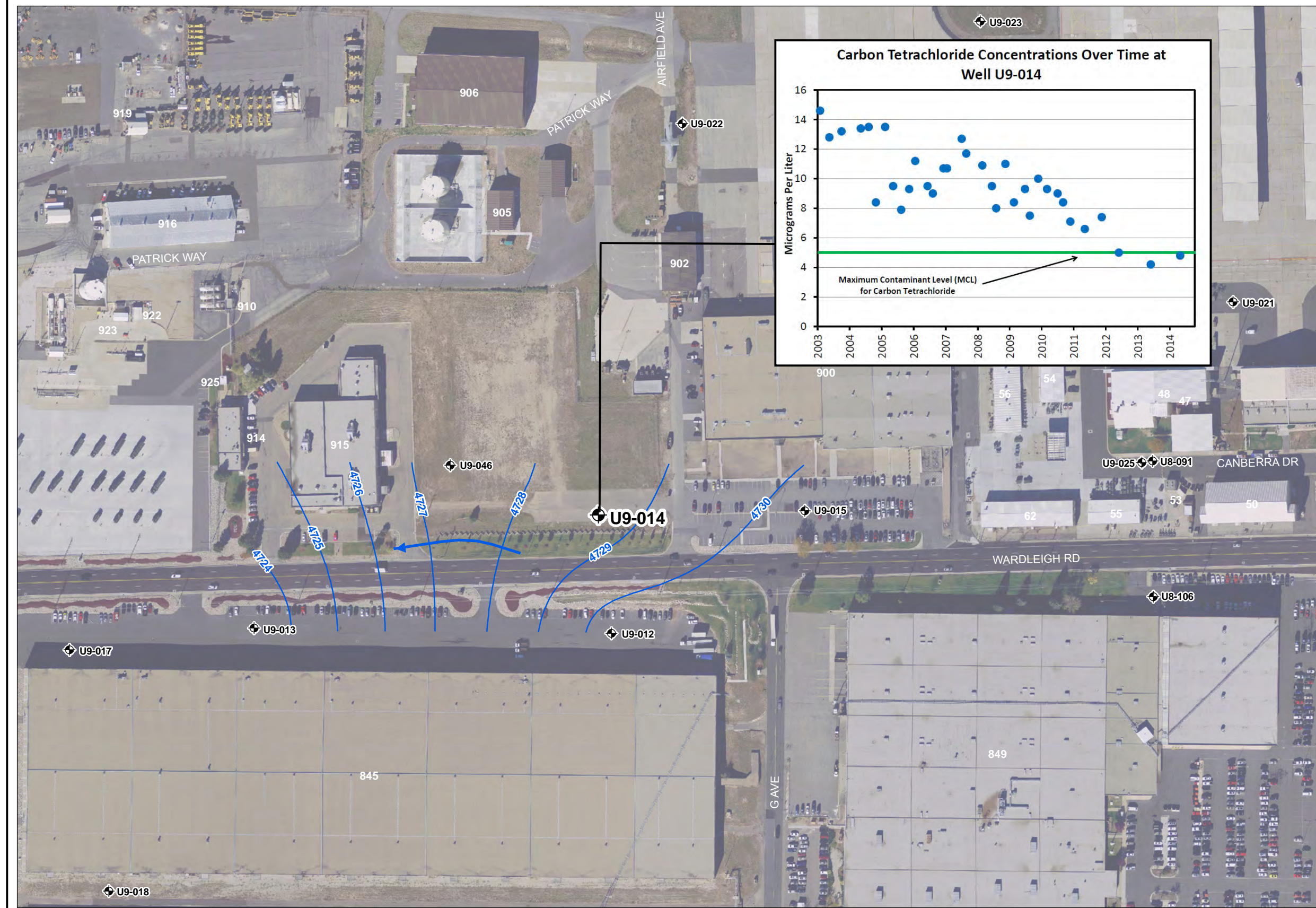


FIGURE 2-1
OPERABLE UNIT 9 — INSTALLATION RESTORATION PROGRAM SITES
OPERABLE UNIT 9 RECORD OF DECISION
HILL AIR FORCE BASE, UTAH

THIS PAGE INTENTIONALLY LEFT BLANK



0 100 200 400 Feet
1 inch equals 200 feet

LEGEND

- Monitoring Well
- Groundwater Potentiometric Surface (ft amsl)
- Shallow Groundwater Flow Direction (Approximately 7.3 to 13 ft/yr)

Acronym(s) and Abbreviation(s):
 µg/L = Microgram(s) per liter
 amsl = Above mean sea level
 ft = Feet (foot)
 ft/yr = Feet per year
 MCL = Maximum Contaminant Level

Note(s):
 No monitoring wells at Site SS108 800/900 Area currently contain carbon tetrachloride concentrations above its MCL (5 µg/L). Geographic data for the study area were projected using coordinate system World Geodetic System 1984 Universal Transverse Mercator Zone 12N.

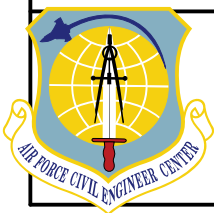
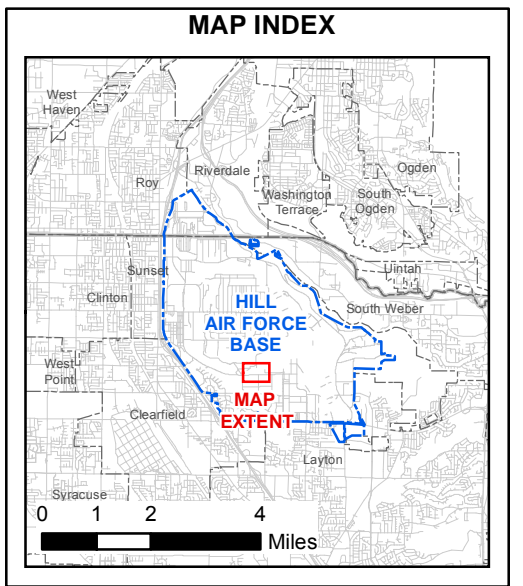
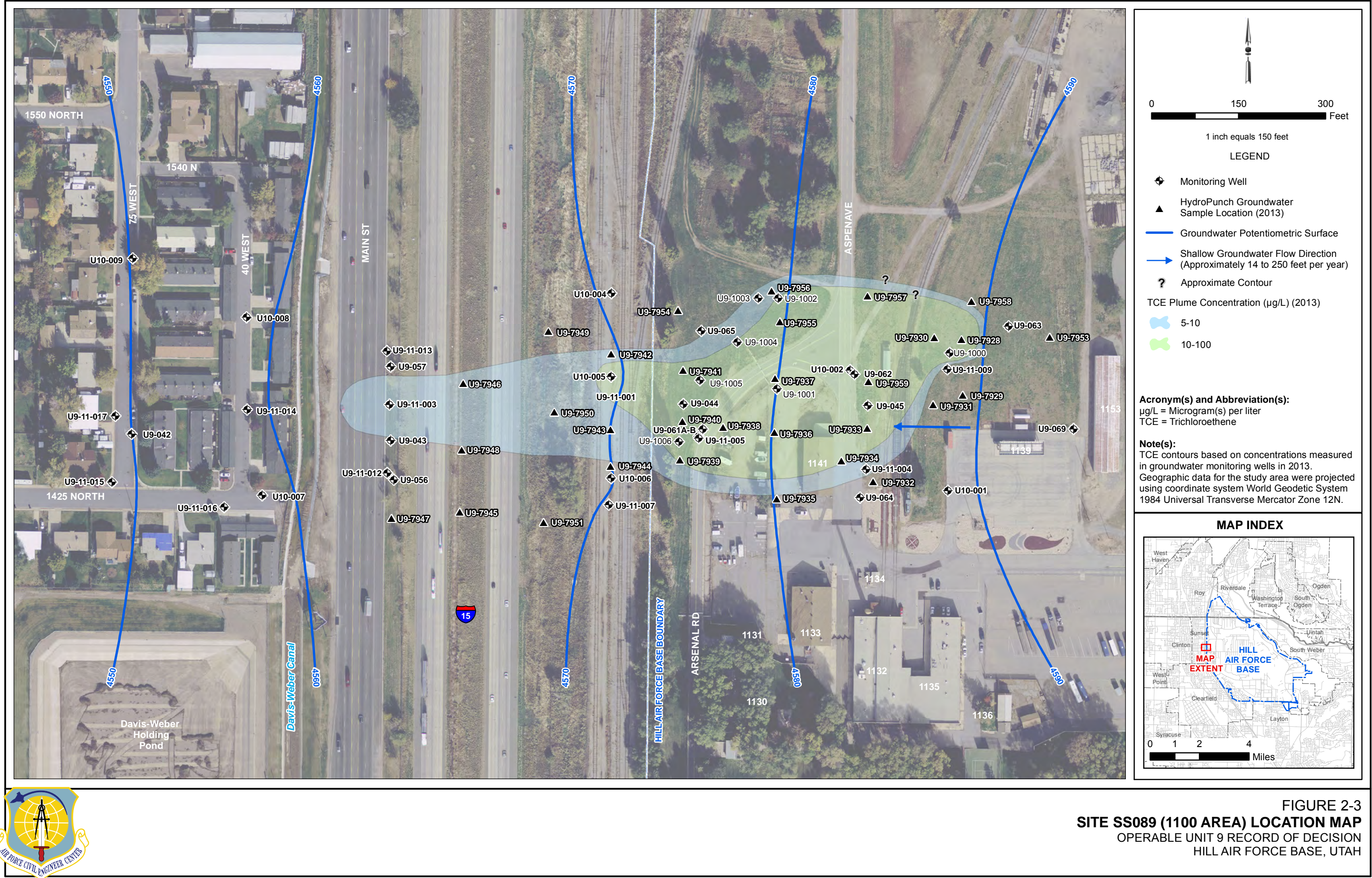


FIGURE 2-2
SITE SS108 (800/900 AREA) LOCATION MAP
 OPERABLE UNIT 9 RECORD OF DECISION
 HILL AIR FORCE BASE, UTAH

THIS PAGE INTENTIONALLY LEFT BLANK



THIS PAGE INTENTIONALLY LEFT BLANK

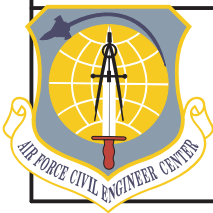
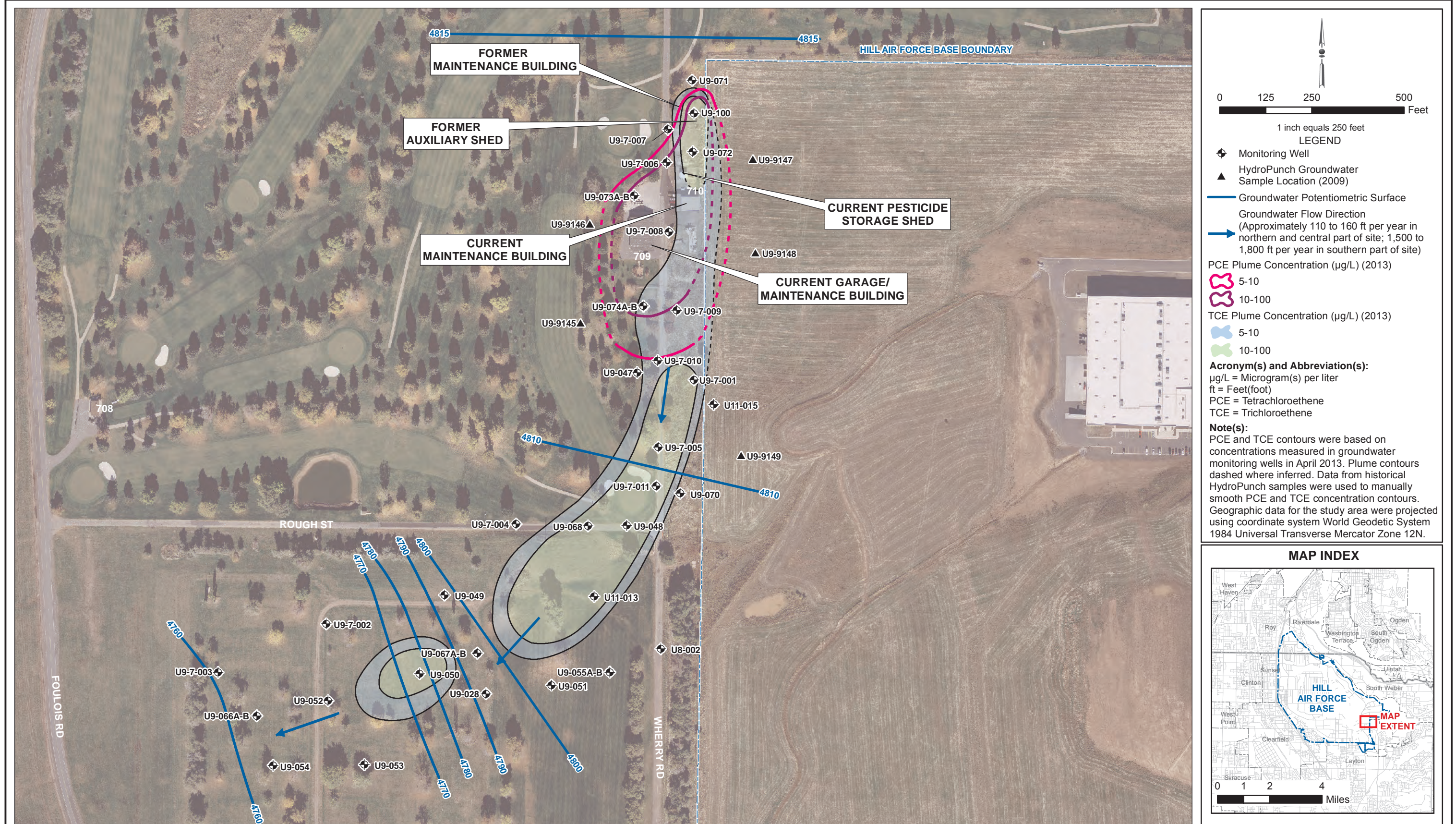
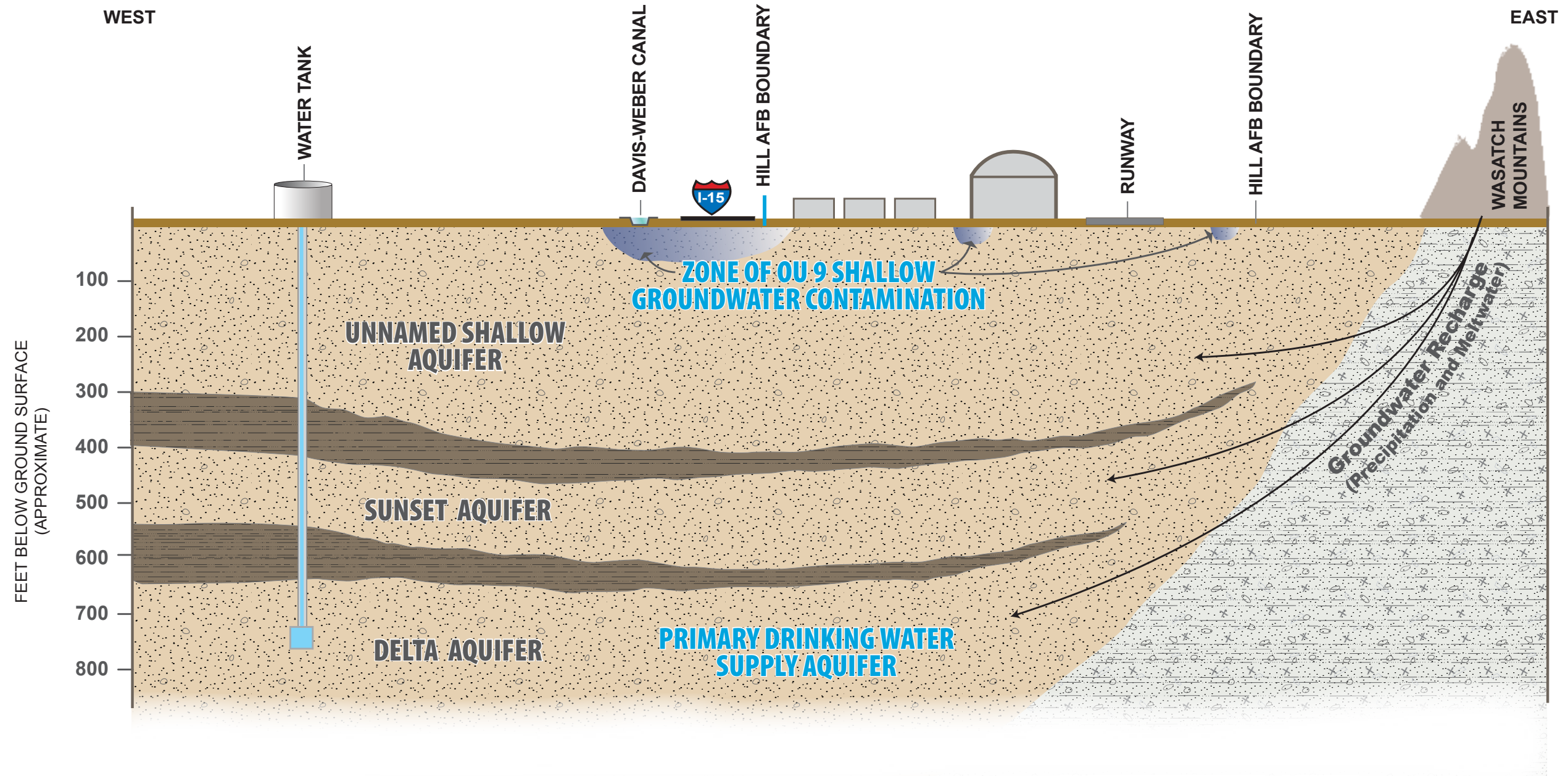


FIGURE 2-4
SITE SS090 (GOLF COURSE AREA) LOCATION MAP
OPERABLE UNIT 9 RECORD OF DECISION
HILL AIR FORCE BASE, UTAH

THIS PAGE INTENTIONALLY LEFT BLANK



Acronym(s) and Abbreviation(s):
 AFB = Air Force Base
 OU = Operable Unit

NOT TO SCALE

LEGEND

- AQUIFER SAND DEPOSITS
- IMPERMEABLE SILT AND CLAY DEPOSITS
- BEDROCK
- GROUNDWATER CONTAMINATION



FIGURE 2-5
 REGIONAL AQUIFER SYSTEM CONCEPTUAL MODEL
 OPERABLE UNIT 9 RECORD OF DECISION
 HILL AIR FORCE BASE, UTAH

THIS PAGE INTENTIONALLY LEFT BLANK



THIS PAGE INTENTIONALLY LEFT BLANK

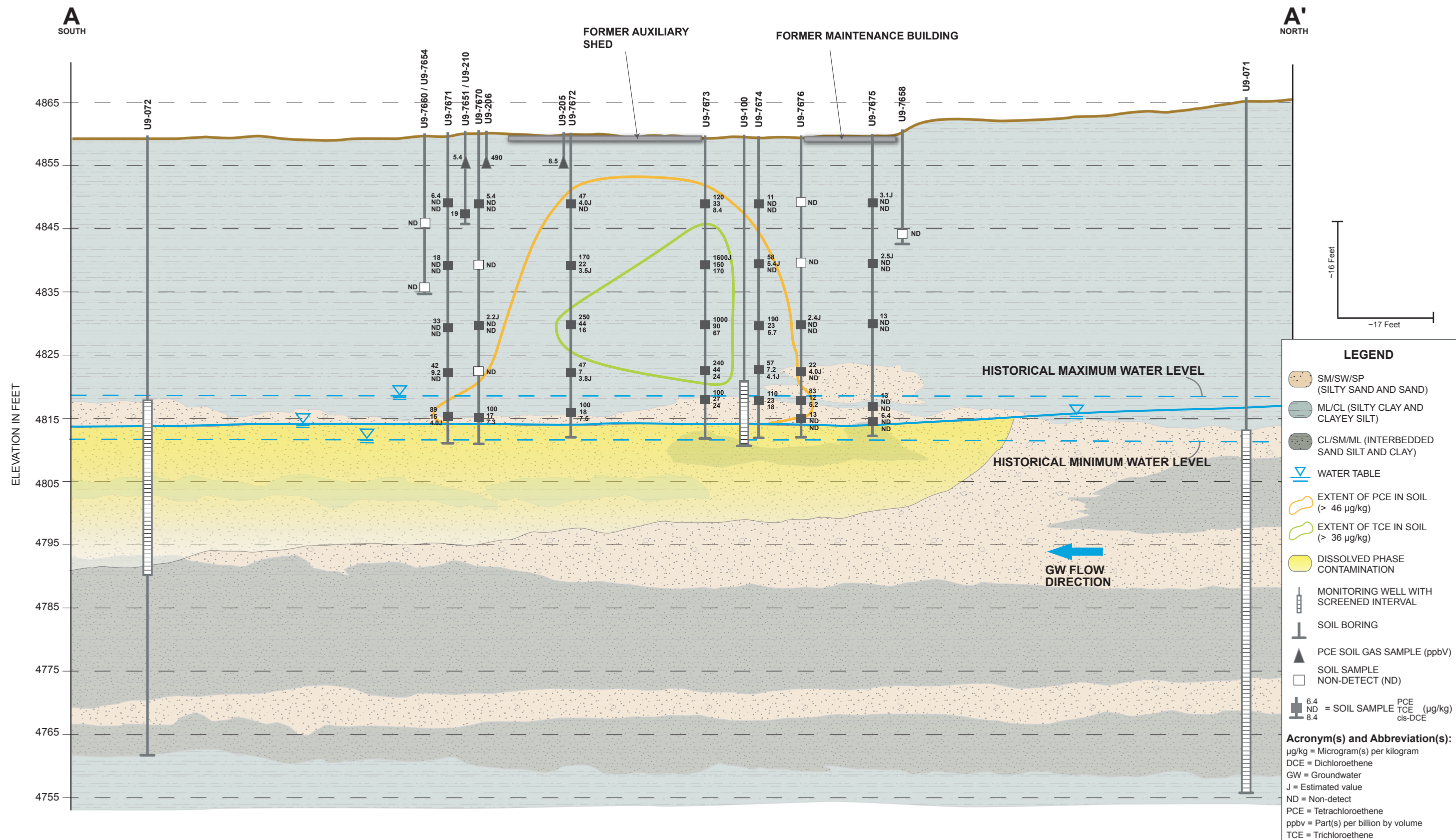
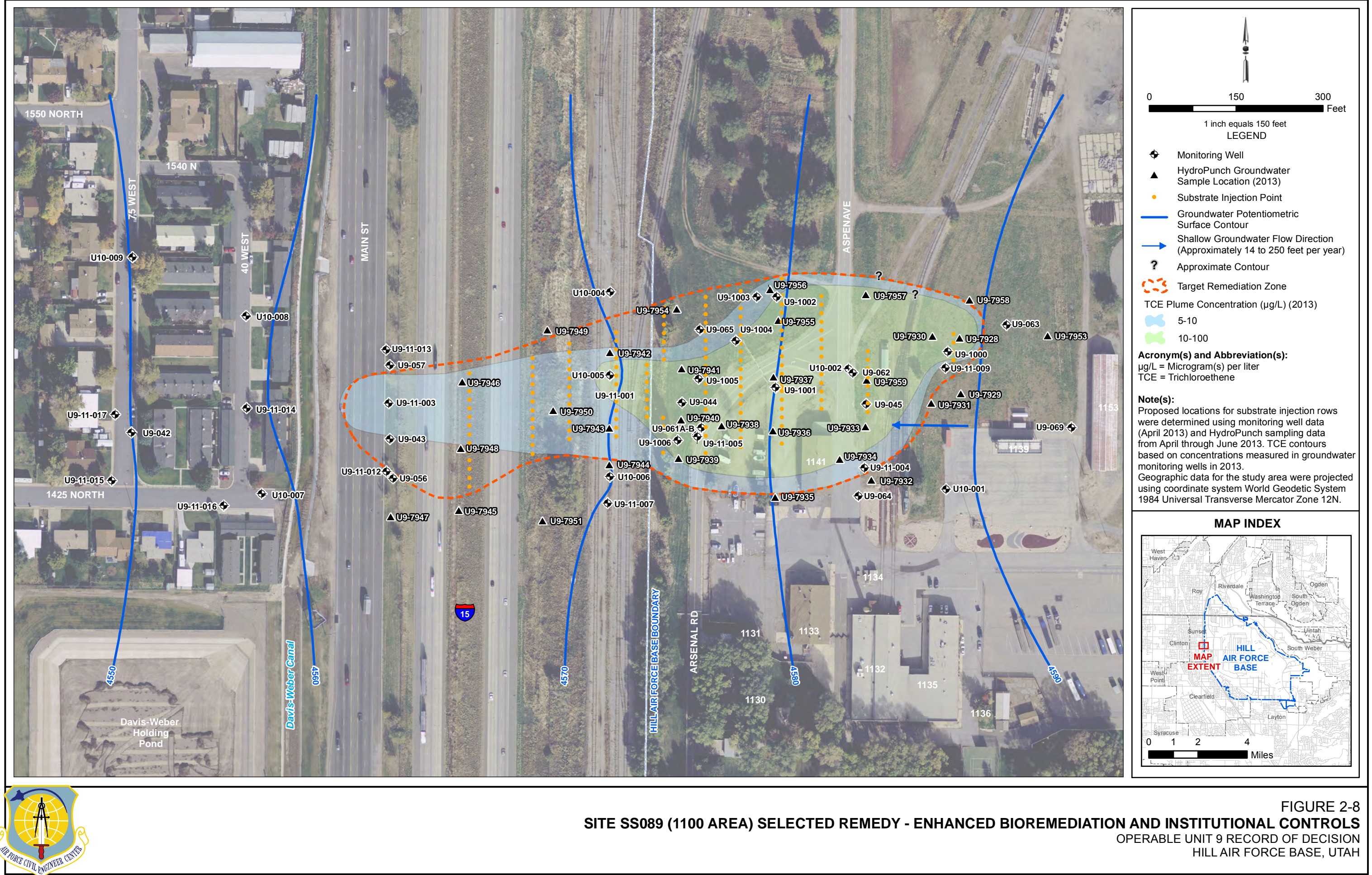


FIGURE 2-7
SITE SS090 (GOLF COURSE AREA) CROSS SECTION A-A'
OPERABLE UNIT 9 RECORD OF DECISION
HILL AIR FORCE BASE, UTAH

THIS PAGE INTENTIONALLY LEFT BLANK



THIS PAGE INTENTIONALLY LEFT BLANK

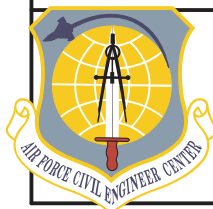
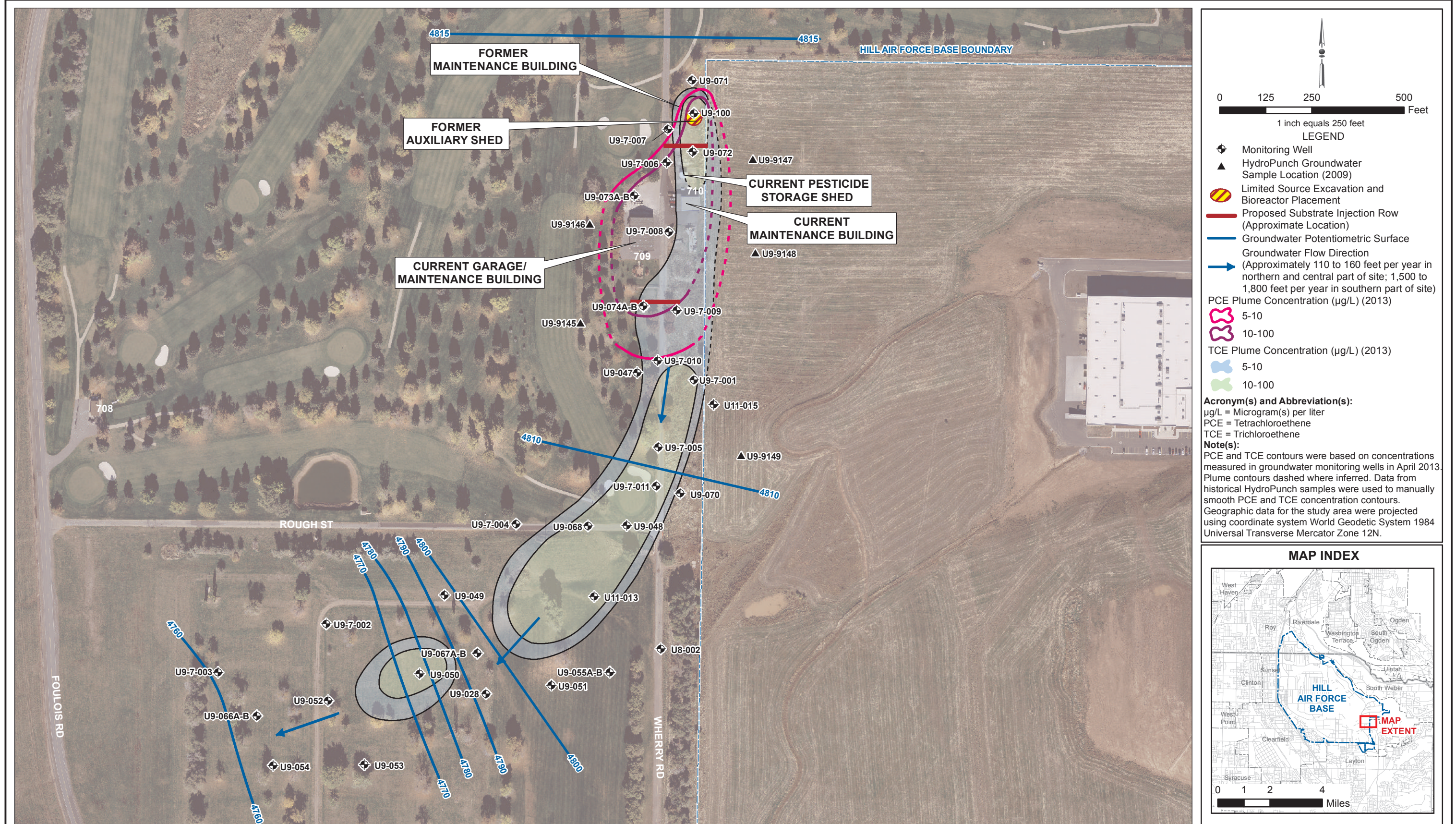


FIGURE 2-9
SITE SS090 (GOLF COURSE AREA) SELECTED REMEDY -
LIMITED EXCAVATION, ENHANCED BIOREMEDIATION, MONITORED NATURAL ATTENUATION, AND INSTITUTIONAL CONTROLS
OPERABLE UNIT 9 RECORD OF DECISION
HILL AIR FORCE BASE, UTAH

THIS PAGE INTENTIONALLY LEFT BLANK

3.0 Responsiveness Summary

3.1 Overview

The purpose of this section is to present the USAF responses to general public comments on the Proposed Plan. These responses are known as the responsiveness summary and are a requirement of the CERCLA process. The EPA and UDEQ are required to review and concur with the responses to public comments before the ROD can be finalized.

3.2 Background on Community Involvement

The USAF followed a remedy selection process in accordance with the public participation requirements of CERCLA Sections 113(k)(2)(B)(i-iv) and 117. Additional requirements as outlined in the Hill AFB Environmental Restoration Community Relations Plan (Hill AFB 1997) also were fulfilled. The USAF meets quarterly with members of the Hill AFB Restoration Advisory Board, which consists of approximately 25 people representing the local communities; federal, state, county, and city governments; local sewer and water districts; civic, business, and environmental groups; the USAF, and other interested parties. Restoration Advisory Board meetings are advertised in local newspapers and open to the public. Community concerns are solicited and addressed prior to making a final proposal.

The public was informed of the selected remedial actions through the following actions:

- All items contained within the Administrative Record file for OU 9 are available online at the U.S. Air Force Civil Engineer Center, Air Force Administrative Record, <http://afcec.publicadmin-record.us.af.mil/>.
- A notice of availability of the Proposed Plan and opportunity for public comment was published in the Ogden Standard Examiner on 24 September 2014.
- A public meeting presenting the proposed remedy was held on 8 October 2014 at the Sunset City Offices in Sunset, Utah.
- A public comment period for the Proposed Plan was held from 1 October to 31 October 2014.
- Written comments by the public were encouraged.

3.3 Summary of the Public Meeting and Public Comments

An open house public meeting for OU 9 was held from 5:00 to 7:00 p.m. on Wednesday, 8 October 2014 at the Sunset City Offices in Sunset, Utah. Representatives from Hill AFB, the EPA, and UDEQ were available to explain and answer questions about the results of the investigations and the proposed remedies for OU 9. A sign-in sheet with the names of those in attendance at the public meeting is included in Appendix A.

No comments were received during the public meeting, nor were any comments received during the public comment period.

THIS PAGE INTENTIONALLY LEFT BLANK

4.0 References

- CH2M HILL. 2001. *Comprehensive Data Evaluation for the South Area of Operable Unit 9 Site Inspection*, Hill Air Force Base, Utah. February.
- CH2M HILL. 2002a. *Engineering Evaluation/Cost Analysis for the OU 9 Pond 1 Removal Action*, Hill Air Force Base, Utah. April.
- CH2M HILL. 2002b. *Building 786 No Further Response Action Planned Decision Document*, Hill Air Force Base, Utah. September.
- CH2M HILL. 2002c. *Action Memorandum, Operable Unit 9 – Pond 1*, Hill Air Force Base, Utah. September.
- CH2M HILL. 2002d. *Operable Unit 11 Analytical Data Report, May 1, 2001 - January 31, 2002, Operable Unit 11 Remedial Investigation/Feasibility Study*, Hill Air Force Base, Utah. November.
- CH2M HILL. 2003. *Engineering Evaluation/Cost Analysis for the Operable Unit 9 Pond 3 Removal Action*, Hill Air Force Base, Utah. June.
- CH2M HILL. 2004a. *Operable Unit 9 Pond 1 Remedial Action Report*, Hill Air Force Base, Utah. September.
- CH2M HILL. 2004b. *Final Action Memorandum, Operable Unit 9 – Pond 3*, Hill Air Force Base, Utah. January.
- CH2M HILL. 2004c. *Pond 3 Remedial Action Construction Report*, Hill Air Force Base, Utah. May.
- CH2M HILL. 2005a. *Operable Unit 9 Remedial Investigation Report*, Hill Air Force Base, Utah. Final. April.
- CH2M HILL. 2005b. *Pond 7 Area No Further Response Action Planned Decision Document*, Hill Air Force Base, Utah. February.
- CH2M HILL. 2005c. *Operable Unit 9 Feasibility Study Report*, Hill Air Force Base, Utah. Final. August.
- CH2M HILL. 2009a. *TCE Plume Evaluation for the 800/900 Area, Hill AFB, Utah – Investigation Results*, Hill Air Force Base, Utah. May.
- CH2M HILL. 2009b. *Operable Unit 10 Feasibility Study Report*, Hill Air Force Base, Utah. September.
- CH2M HILL. 2010a. *Revised Operable Unit 9 Feasibility Study Report*, Hill Air Force Base, Utah. Final. September.
- CH2M HILL. 2010b. *2009 Soil and Soil Gas Investigation Results for Operable Unit 9, Hill Air Force Base, Utah*, Hill Air Force Base, Utah. May.

- EA Engineering, Science, and Technology, Inc., PBC. (EA). 2014a. *Operable Unit 9 Feasibility Study Supplement*, Hill Air Force Base, Utah. Final. October.
- EA. 2014b. *Operable Unit 9 – Site SS089 1100 Area Treatability Study Work Plan*, Hill Air Force Base, Utah. February.
- EA. 2014c. *Operable Unit 9 Proposed Plan*, Hill Air Force Base, Utah. Final. September.
- EA. 2014d. *Operable Unit 9 – Site SS089 1100 Area Treatability Study Performance Technical Memorandum*, Hill Air Force Base, Utah. Final. December.
- EA. 2015a. *Operable Unit 9 – Site SD034 (Pond 1 Area) Action Memorandum Addendum*, Hill Air Force Base, Utah. Final. June.
- EA. 2015b. *Operable Unit 9 – Site SD040 (Pond 7 Area) No Further Response Action Planned Decision Document Addendum*, Hill Air Force Base, Utah. Final. June.
- Engineering Science. 1991. *Site Investigation Report, UST Release Response, Building 1141*.
- Environmental Simulations Inc. 2007. *Guide to Using Groundwater Vistas Version 5*. Reinholds, Pennsylvania.
- (U.S.) Environmental Protection Agency (EPA). 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies under Comprehensive Environmental Response, Compensation, and Liability Act*. Interim Final. October.
- EPA. 1989. *Risk Assessment Guidance for Superfund: Volume I—Human Health Evaluation Manual (Part A)*. Interim Final. EPA/540/1-89/002. Office of Emergency and Remedial Response. December.
- EPA. 1996. *Soil Screening Guidance: User's Guide*. Second Edition. Office of Solid Waste and Emergency Response Publication 9355.4-23. July.
- EPA. 1998. *Management of Remediation Waste under RCRA, EPA530-F-98-026*. October.
- EPA. 1999a. *A Guide for Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents*. EPA 540-R-98-031. July.
- EPA. 1999b. *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*. Office of Solid Waste and Emergency Response (OSWER) Directive 9200.4-17P. April.
- EPA. 2000. *A Guide to Preparing and Documenting Cost Estimates during the Feasibility Study*. EPA 540-R-00-002. July.
- EPA. 2004. *Risk Assessment Guidance for Superfund—Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)*. Final. EPA/540/R/99/005. Office of Superfund Remediation and Technology Innovation. July.

- EPA. 2009. *Risk Assessment Guidance for Superfund—Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment)*. Final. EPA-540-R-070-002. Office of Superfund Remediation and Technology Innovation. January.
- EPA. 2013. Federal MCL: <http://www.epa.gov/safewater/contaminants/index.html>. Utah MCL: <http://www.rules.utah.gov/publicat/code/r309/r309-200.htm>. Accessed February 15, 2015.
- EPA. 2014a. *Superfund Program Hill Air Force Base*. <http://www2.epa.gov/region8/hill-air-force-base>. Last Updated October 2, 2014.
- EPA. 2014b. *Memorandum: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*. Office of Solid Waste and Emergency Response Directive 9200.1-120. February.
- EPA. 2014c. *Screening Tools for Chemical and Radionuclide Contaminants*. http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search. Accessed December 2014.
- EPA. 2015. *Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites*. June.
- ERM-Rocky Mountain, Inc. (ERM). 1993. *Final Preliminary Assessment/Site Investigation for Pond 6*. September.
- Feth, J.H., D.A. Barker, L.G. Moore, R.J. Brown, and C.E. Veirs. 1966. *Lake Bonneville: Geology and Hydrology of the Weber Delta District, including Ogden, Utah*. U.S. Geological Survey Professional Paper 518.
- Hill Air Force Base (AFB). 1997. *Environmental Restoration Community Relations Plan*, Hill Air Force Base, Utah. December.
- Hill AFB. 2012. *Operable Unit 9 Performance Standard Verification Plan*, Hill Air Force Base, Utah. May.
- HydroGeoLogic. 2006. *MODFLOW-SURFACT Software (Version 3.0), Overview: Installation, Registration, and Running Procedures*. Herndon, Virginia.
- JRW Bioremediation. 2013. *LactOil Soy Microemulsion*. <http://www.jrwbioremediation.com/lactoil.html>. Accessed October 2013.
- Layton City. 2015a. *Layton City Zoning*. <http://www.laytoncity.org/public/depts/comdev/GIS/default.aspx>. Accessed January 2015.
- Layton City. 2015b. *Economic Development: East Gate Industrial/Business Park Development*. <http://www.laytoncity.org/public/depts/comdev/ED/IndustrialPark.aspx>. Accessed January 2015.
- Montgomery Watson (MW). 1994. *South Area Preliminary Assessment Report (SAPA)*, Hill Air Force Base, Utah. April.
- MW. 1995. *North Area Preliminary Assessment Report (NAPA)*, Hill Air Force Base, Utah. June.
- MW. 1998. *PCB Delineation Report for Buildings 2402 & 2403 and the Used Transformer Storage Yard*, Hill Air Force Base, Utah. July.

MW. 1999. *PCB Removal Report for Buildings 2402 & 2403 and the Used Transformer Storage Yard*, Hill Air Force Base, Utah. October.

MW. 2000. *Revised Final Second Edition Site Inspection Report for Operable Unit 9 North Area*, Hill Air Force Base, Utah. July.

MW. 2001. *Base-Wide CPT Report Letter Report and Attachments 1 – 5*, Hill Air Force Base, Utah. April.

Montgomery Watson Harza (MWH). 2001. *Final Remedial Investigation Report for Operable Unit 8*, Hill Air Force Base, Utah. December.

MWH. 2004. *Final Basewide Air Sampling and Analysis Plan, Indoor Residential Air Sampling*. Hill Air Force Base, Utah. January.

North Wind. 2008. *Enzyme Activity Probe Assessment of Groundwater: Hill Air Force Base, OU-9*. May.

Select Engineering Services (SES). 2011. *The Environmental Restoration Management Action Plan*, Hill Air Force Base, Utah. February.

Simunek, J., M. Th. van Genuchten, and M. Sejna. 2008. *The HYDRUS-1D Software Package for Simulating the One-Dimensional Movement of Water, Heat, and Multiple Solutes in a Variably Saturated Media. Version 4.0. HYDRUS Software Ser. 3*. Dept. of Environmental Sciences. University of California, Riverside.

Sunset City Planning Commission. 2012. *Sunset City General Plan*. September.

Utah Administrative Code. 2014. *Rule R317-6. Date of Enactment or Last Substantive Amendment*. November.

Utah Division of Water Rights (DWRi). 1995. *Groundwater Management Plan for the Weber Delta Sub-Area of the East Shore Area*. October

van Genuchten, M.Th., J.M. Davidson, and P.J. Wierenga. 1974. “*An Evaluation of Equilibrium Equations for the Predictions of Pesticide Movement through Porous Media.*” Soil Science Society of America Proceedings. Vol. 38. pp. 29–35.

White House Office of Management and Budget. *Circular A-94*.
http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c/.

Appendix A
Notice of Availability
and Public Meeting Sign-in Sheet

THIS PAGE INTENTIONALLY LEFT BLANK

WORLD & NATION

Man charged with abduction

CHARLOTTESVILLE, Va. — The man authorities believe was the last person seen with a University of Virginia student before she disappeared has been charged with abduction, police said Tuesday night.

Charlottesville Police Chief Timothy Longo said at a news conference that officers are looking for Jesse Leroy Matthew Jr., 32, after obtaining a felony arrest warrant from a magistrate on a charge of abduction with intent to defile. They also continue to search for Hannah Graham, 18, who went missing early the morning of Sept. 13.

Matthew was last seen Saturday when he stopped by the police station with his mother and uncle to ask for a lawyer. Police say he sped away afterward, losing officers who had him under surveillance and prompting authorities to issue two arrest warrants for reckless driving.

Longo said police, who have searched Matthew's car once and his apartment twice, decided they had probable cause to charge him in Graham's disappearance. He declined to say what new information police had, and he did not take questions.

Matthew has been employed at the University of Virginia Medical Center since Aug. 12, 2012, as a patient technician in the operating room, said university spokesman McGregor McCance.

Fire destroys Brown memorial

FERGUSON, Mo. — Anger spilled over Tuesday after fire destroyed one of two memorials on the street where Michael Brown was killed, a site that has become sacred to many in Ferguson and others nationwide focused on interactions between minorities and police.

How the fire happened wasn't immediately clear, but it stoked fresh resentment among those who question whether the shooting of the unarmed, black 18-year-old by a white Ferguson police officer Aug. 9 is being adequately investigated.

"It's the same as if somebody came and desecrated a grave," Anthony Levine of Florissant, another St. Louis suburb, said as he studied the charred scene and shook his head.

Many who gathered at the site Tuesday blamed police for the blaze, even as the chief said officers did everything they could to keep the stuffed animals and other items from burning.

Obama: Reduce emissions

UNITED NATIONS — In the first international test for his climate-change strategy, President Barack Obama pressed world leaders Tuesday to follow the United States' lead on the issue, even as a United Nations summit revealed the many obstacles that still stand in the way of wider agreements to reduce heat-trapping pollution.

"The United States has made ambitious investments in clean energy and ambitious reductions in our carbon emissions," Obama said. "Today, I call on all countries to join us, not next year or the year after that, but right now — because no nation can meet this global threat alone."

The largest-ever gathering of world leaders to discuss climate was designed to lay the groundwork for a new global climate-change treaty.

— *The Associated Press*

Wind energy would be stored in Utah caverns

In this 2009 photo, a wind mill, rear center, supplies water to a stock tank surrounded by wind turbines of the Smoky Hills Wind Project near Wilson, Kansas.

Associated Press file photo



\$8B proposal aims to send Wyoming wind energy to Los Angeles area within a decade

The Associated Press

LOS ANGELES — An alliance of four companies proposed an \$8 billion project Tuesday that within a decade could send wind power generated on the plains of Wyoming to households in Southern California.

If approved and financed, the sprawling venture would produce clean power equivalent to the output of a large nuclear power plant by creating one of the country's largest wind farms near Cheyenne, Wyoming, a huge energy storage site inside Utah caverns and a 525-mile electric transmission line connecting them.

"This would certainly be one of the most ambitious and expensive energy infrastructure projects we have seen," said Travis Miller, an industry analyst for investment research giant Morningstar Inc.

"Energy storage, paired with renewable energy, has been the holy grail of utilities and energy companies," Jeff Meyer, of Pathfinder Renewable Wind Energy, onecompany behind the plan, described it as "the 21st century's Hoover Dam," referring to the 726-foot-high span across the Colorado River that for decades has produced hydroelectric power for Nevada, Arizona and California.

The announcement came on the same day that President Barack Obama pressed world leaders to follow the United States' lead on climate change in a one-day United Nations summit aimed to gather support for a climate-change treaty to reduce heat-trapping pollution.

The new proposal, with a tentative completion date of 2023, would potentially generate twice as much energy as the 1930s-era dam. Success hinges on a string of uncertainties, including

clearing government regulatory hurdles and striking agreements to sell the power that would be essential to secure financing.

With potential shifts in government policy, environmental regulation and the economics of producing green power, "any infrastructure project that looks out nine, 10 years, has a lot of uncertainties," Miller said.

Pathfinder Energy, Magnum Energy, Dresser-Rand and Duke-American Transmission Co. said in a statement they plan to submit the blueprint to the Southern California Public Power Authority by early 2015.

California agency officials said they were unaware of the proposal. The authority has been seeking proposals to supply the Los Angeles region with renewable power required under state law.

The new plan "would be competing with 200 other proposals," said Steven Homer, the director of project management for the authority, whose members deliver electricity to approximately 2 million customers.

Wind development in Wyoming's wide expanses has surged in the past decade as companies and state officials seek cleaner alternatives to coal.

The proposed wind power development near Chugwater would be a boon to the sleepy ranching town of 216 residents nestled below sandstone bluffs on the high prairie.

A decade ago, in a desperate bid to revive their economically depressed community, town officials sold city lots for \$100 apiece on the condition that the buyer would build a house and live there at least two years. Results were mixed, at best: Chugwater's population dropped 11 percent from 2000 to 2012, even as Wyoming's overall economy grew and

population increased.

If completed, it would become Wyoming's second-largest wind power project. The biggest is a 1,000-turbine site planned by The Anschutz Corp. That project near Saratoga, in south-central Wyoming, is the largest under development in the U.S.

The rapid growth in wind power has come with a cost, however. The U.S. government estimates at least 85 eagles are killed each year by wind turbines. An Associated Press investigation in 2013 revealed that the Obama administration was not prosecuting wind energy companies for killing eagles and other protected birds.

A lynchpin in the plan would be a \$1.5 billion energy storage site near Delta, Utah, 130 miles southwest of Salt Lake City. The rural area already is home to one coal-powered plant that generates electricity for Los Angeles County.

With the push for pollution-free energy sources that can help reduce greenhouse gases blamed for global warming, billions of dollars have been invested in wind and solar projects. Finding an economical way to store renewable energy, however, has been a key issue.

Under the proposal, the energy would be stored through a compressed-air system using caverns, similar to a system that has been used in Alabama since the early 1990s.

When energy demand is low, excess electricity would be used to compress and inject high-pressure air into the four caverns, each of which would have 41 million cubic feet of volume.

At times of high energy demand, the high-pressure air would be combined with a small amount of natural gas to power eight electricity-producing generators.

Things to know about \$8B wind energy proposal

CHEYENNE, Wyo. — An alliance of four companies has proposed an \$8 billion project to supply the Los Angeles area with large amounts of electricity from a wind farm in Wyoming. Here are a few things to know about the ambitious project:

• **COMPRESSED AIR:** Wyoming wind seems to blow year-round, but it's actually a lot windier during winter. Since Los Angeles residents use more energy in summer, developers plan to build a massive battery of sorts in Utah. The plan involves four underground chambers — a quarter-mile high and almost as wide as a football field — that would store compressed air. Electric pumps would fill the caverns during times of high wind and low demand. It would then be released during times of low wind and high demand, driving turbines that would boost electricity back onto the grid.

• **NOT COAL:** The nation's top coal producer has no state mandate requiring utilities to obtain a certain percentage of their electricity from renewable sources. Yet, Wyoming's abundant wind and unpopulated expanses offer vast options for developers to help utilities in California, Colorado and other states meet their requirements. Wind presents an alternative as Wyoming officials travel to the Far East seeking buyers for coal.

• **NOT (QUITE) THE BIGGEST:** The \$8 billion project would involve building enough wind turbines to power 1.2 million homes with 2,100 megawatts of electricity. That's a big wind farm — but not quite the biggest on the drawing boards in Wyoming. In the works is a 1,000-turbine, 3,000-megawatt development that Denver-based The Anschutz Corp. is planning near Saratoga in south-central Wyoming. The electricity from this project also is targeted at California.

• **SPECIES IN THE WAY:** Wind turbines kill large numbers of birds, including federally protected bald and golden eagles. Both species are abundant in Wyoming, yet securing an "eagle take" permit for a massive wind farm could prove easier said than done. Anschutz officials have been waiting for months to secure a permit from the U.S. Fish and Wildlife Service for their project.

• **BOON TO CHUGWATER:** The wind farm will be built near a picturesque, oddly named town on Wyoming's high plains with a population of 200 and falling, despite a plan a decade ago to lure residents by selling city lots for \$100 apiece. Any hint of economic development — let alone a huge wind farm — is sure to be welcome news for Chugwater.

— *The Associated Press*

Angels & Survivors

Throughout the month of October, the Standard-Examiner is creating a special section honoring Breast Cancer Angels and Survivors.



A portion of all tributes will be donated to the Image Reborn Foundation.

Survivor
Susan Lou Anne Smith

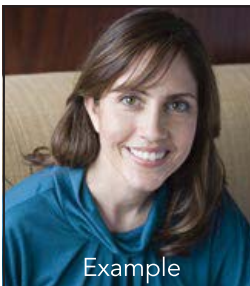


Example

You are a survivor, 15 years and counting! We are so proud of the way that you battled breast cancer. You are an inspiration to those around you. You are a grandmother, mother, wife and friend to so many who love and admire you. We are better people because we know you. Stay strong! Love, Brian, James, Tricia, Steve, Lisa and all of the kids!

↑ Ribbon Option

Banner Option ↓



Example

ANGEL

Emma Park
June 3, 1971 ~ July 15, 2013

It has been just over a year since you left us. Not a day goes by that we don't think of you and your amazing courage. You are forever in our hearts.

We love you!

Your loving husband Jeff, and your beautiful children, Megan, Matthew, William and Lysie.

Tributes start at \$29.99 and can be placed by emailing announcements@standard.net subject line Breast Cancer Tribute.

Include the following information:
• Name of the woman in the tribute, • Angel or Survivor Photo (optional) • Sentiment (optional) Banner or Ribbon option
Contact Name, Address and Telephone number

Deadline to run in our Special Pink Issue October 1 is September 25 by noon. Subsequent tributes will run on Sundays throughout the month of October. Deadlines for submissions will be the preceding Tuesday by noon.

For more information, or personalized assistance please call 801-625-4400.

Public Comment Opportunity

Oct. 1–30, 2014

The Air Force is accepting comments on the Proposed Plan for cleanup at several independent sites known as Hill Air Force Base Operable Unit (OU) 9.

OU 9 encompasses three sites subject to this Proposed Plan:

- **Site S5108 (800/900 Area):** Located in the southern portion of the base, and consists of carbon tetrachloride (CT) groundwater contamination.
- **Site S5089 (1100 Area):** Located north of the West Gate along the western base boundary, and consists of trichloroethene (TCE) groundwater contamination.
- **Site S5090 (Golf Course Area):** Located along the eastern base boundary, adjacent to Hubbard Golf Course. The site consists of comingled tetrachloroethene (PCE) and TCE groundwater contamination that appears to be associated with solvent use at a former maintenance building and overflow of wastewater from a former catch basin nearby.

OU 9 Proposed Plan includes:

- **Site S5108 (800/900 Area):** Continued monitoring of groundwater to confirm chemicals in the groundwater are naturally degrading.
- **Site S5089 (1100 Area):** Adding a carbon source, such as vegetable oil, to the groundwater to promote the breakdown of TCE.
- **Site S5090 (Golf Course Area):** Adding a carbon source, such as vegetable oil, into groundwater and into monitoring wells across the width of the groundwater contamination to enhance natural degrading of the chemicals, excavation of contaminated soil and monitoring to confirm natural breakdown of contaminants.

Review Proposed Plan at:
Internet: www.hillrab.org/OU9ProposedPlan
Hill AFB Information Repositories located at Weber State University:
Stewart Library, Ogden Campus | For hours, call 801-626-6403
Davis Campus Library, Layton | For hours, call 801-396-3472

OU 9 Proposed Plan Public Meeting
Oct. 8, 2014
5–7 p.m.

Sunset City Offices
Sunset Room, 2nd Floor
200 W. 1300 N., Sunset, Utah

Comment in person at the public meeting, or write to:
Ms. Shannon Smith
Department of the Air Force
AFCEC/CZOM
7290 Weiner Street,
Building 383
Hill AFB, UT 84056-5003

Or via email:
shannon.smith.2@us.af.mil

All comments must be postmarked by Oct. 30, 2014.
Emailed comments must be received by midnight, Oct. 30, 2014.
Media representatives may contact Barbara Fisher at (801) 775-3652.

THIS PAGE INTENTIONALLY LEFT BLANK

10-08-2014 Hill AFB OUG PROPOSED PLAN PUBLIC MTG
1700-1700 SUNSET CITY BUILDING

NAME	ORGANIZATION	CONTACT
Mark Loucks	Hill AFB	801-777-6299
Randy Gates	CH2M HILL	801-557-1595
Ann Dziechciarz	CH2M HILL	801-428-7637
Sandra Bourgeois	U.S. EPA Region 8	303-312-6666
MO SLAM	UDEQ	801-536-4178
SANDRA STAGERMAN	EA	410-215-6142
Shannon Smith	Hill AFB	801-775-6913
DAVE Allison	UDEQ	801-536-4479

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix B
Hill Air Force Base Operable Units and Extent of
Operable Unit 9 Institutional Controls

THIS PAEGE INTENTIONALLY LEFT BLANK

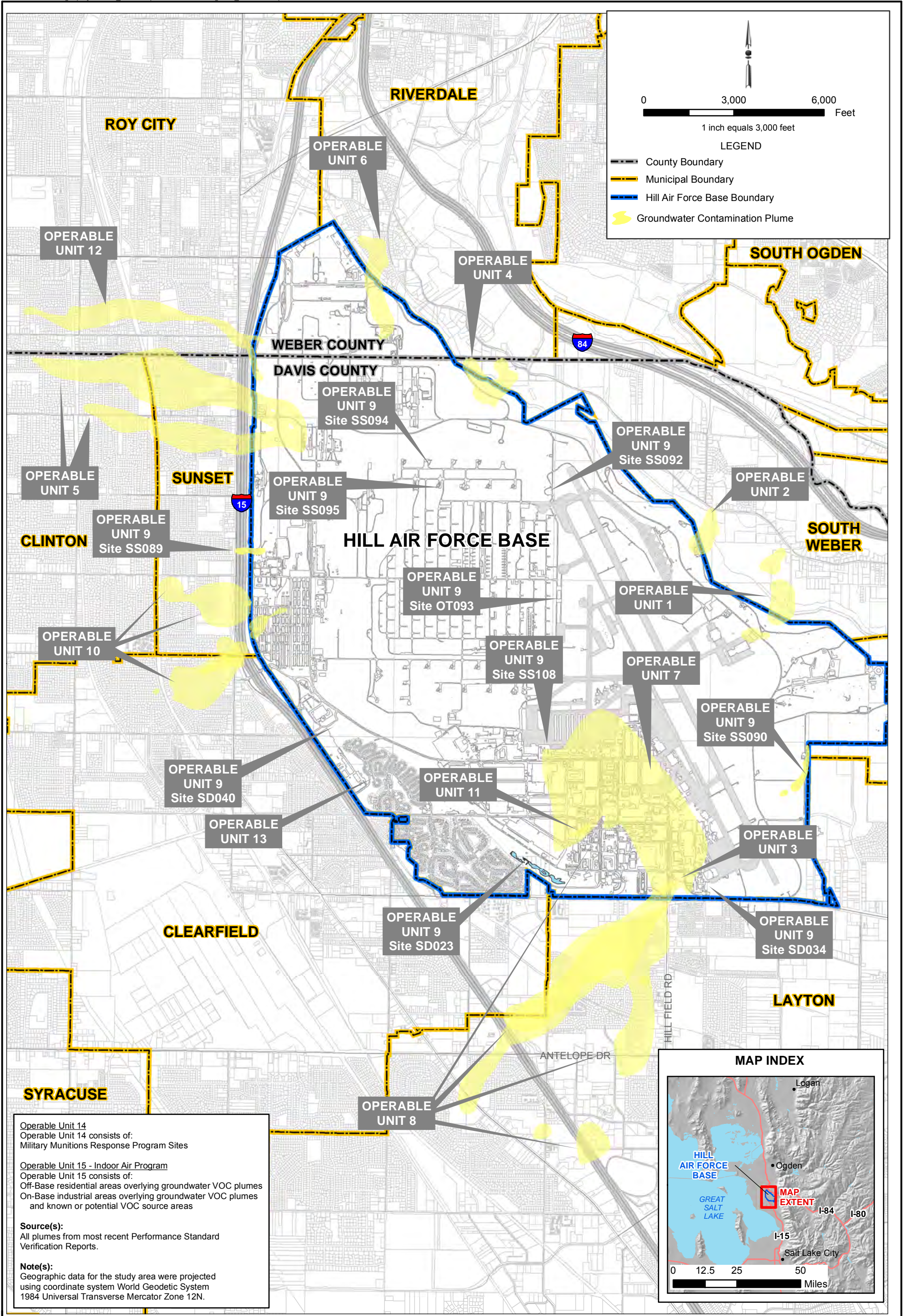


FIGURE B-1
HILL AIR FORCE BASE OPERABLE UNITS
OPERABLE UNIT 9 RECORD OF DECISION
HILL AIR FORCE BASE, UTAH



THIS PAGE INTENTIONALLY LEFT BLANK

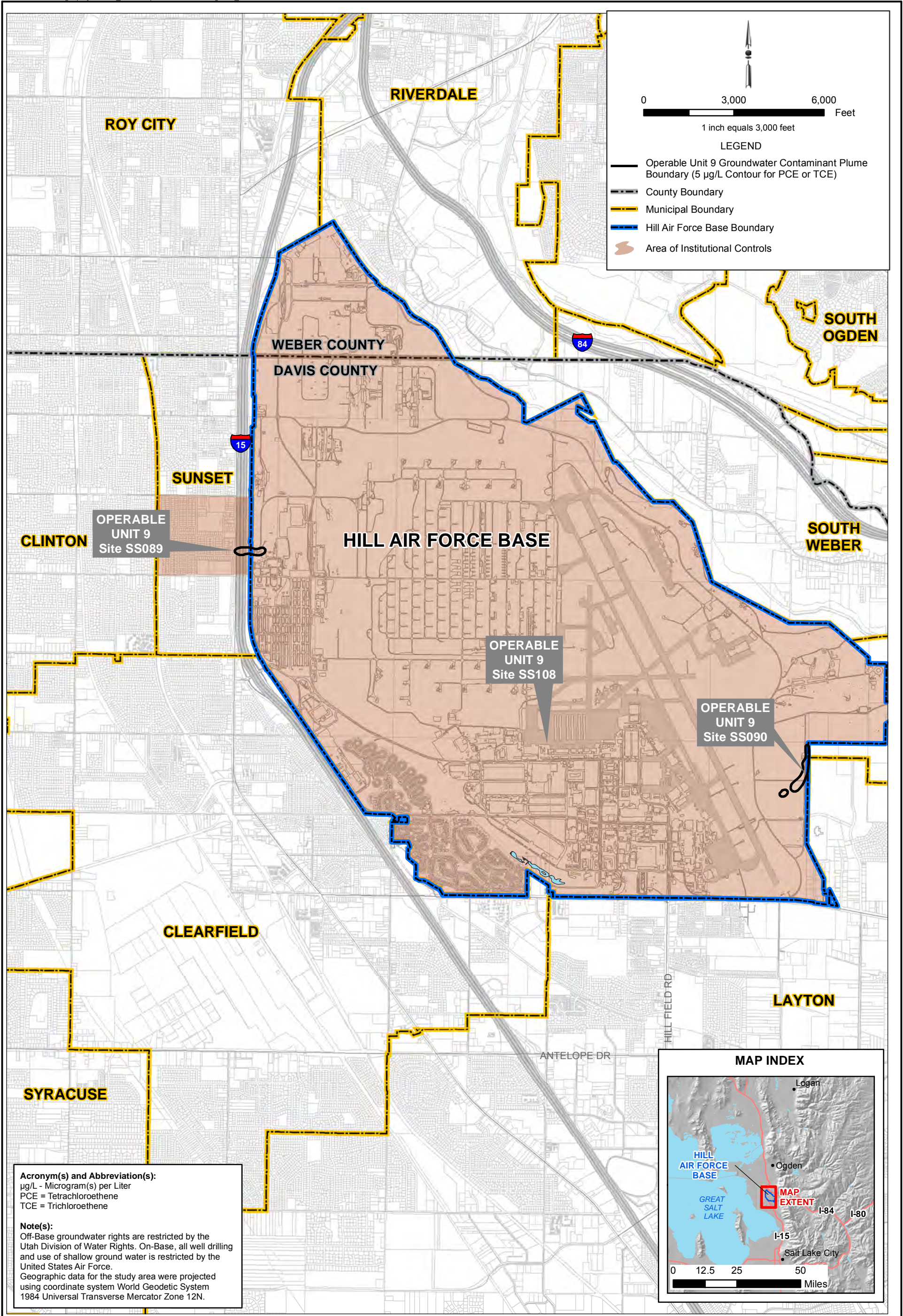
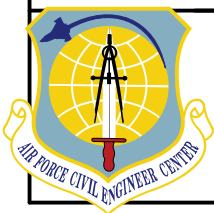


FIGURE B-2
AREAS OF INSTITUTIONAL CONTROLS ASSOCIATED WITH OPERABLE UNIT 9
OPERABLE UNIT 9 RECORD OF DECISION
HILL AIR FORCE BASE, UTAH



THIS PAGE INTENTIONALLY LEFT BLANK

Appendix C
Cost Estimate Summaries
for the Selected Remedies

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE C-1a

Site SS108 (800/900 Area) Alternative 2 - Present Worth Analysis

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

A. CAPITAL COSTS

Item No.	Cost Categories and Items	Description	Unit Cost	Quantity (#)	Units	Total Cost
1	No Action					
	Not applicable	Not applicable				\$0
	Line Item Total					\$0

B. O&M COSTS

Item No.	Cost Categories and Items	Description	Unit Cost	Quantity (#)	Units	Total Cost
1	O&M					
1.1	2013 – 2014 Sampling and Reporting	Four Quarterly Sampling Events and Annual Reporting	\$29,650	2	LS	\$59,300
1.2	2015 Reporting	Site Closeout Report	\$22,578	1	LS	\$22,578
1.3	2016 Well Abandonment	Well abandonment for the 800/900 Area	\$36,795	1	LS	\$36,795
	Line Item Total					\$118,673

C. PRESENT WORTH FOR O&M ACTIVITIES

O&M Present Worth = (O&M) x (P/A), -1.4% for 3 years \$121,330

D. COST SUMMARY

Cost Element	Present Value Cost (\$)
Capital Costs	\$0
O&M (through 2016)	\$121,000
Total Present Worth Costs	\$121,000

NOTES:

A = Annual amount.

i = 2012 Real Discount Rate (3-yr) from OMB-094A (http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c/).

LS = Lump sum.

n = Discount period.

O&M = Operation and maintenance.

P = Present worth.

$$(P/A, i\%, n) = A [((1 + i)^n - 1) / (i (1 + i)^n)]$$

Total Present Worth Costs have been rounded to the nearest \$1,000.

Present worth costs are an estimate for planning purposes only. Actual costs will vary.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE C-1b

Site SS108 (800/900 Area) Alternative 2 - Planning-Level Estimate

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Item/Activity	Quantity	Unit	Unit Cost	Cost	Subtotals	Comments and References
Alternative 2 Total Capital Cost					\$0	
<i>O&M/Performance Monitoring (associated costs)</i>						
Labor (years 2013 through 2014)	2	Annual	\$26,250	\$52,500		
Analytical (years 2013 through 2014)	2	Annual	\$3,400	\$6,800		
Reporting (year 2015)	1	LS	\$22,578	\$22,578		
Well abandonment (year 2016)	1	LS	\$36,795	\$36,795		
<i>O&M/Performance Monitoring (associated costs) Subtotal:</i>					\$118,673	
Alternative 2 O&M/Performance Monitoring Total Cost					\$118,673	

NOTES:

LS = Lump sum.

O&M = Operation and maintenance.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE C-2a

Site SS089 (1100 Area) Alternative 5 - Present Worth Analysis
 Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

A. CAPITAL COSTS

Item No.	Cost Categories and Items	Description	Unit Cost	Quantity (#)	Units	Total Cost
1	Additional Groundwater Investigation					
1.1	Total Capital Cost - 1100 Area	Total capital cost for the additional groundwater investigation at the 1100 Area (refer to Table A-1b for line items)	\$98,320	1	LS	\$98,320
2	LactOil Injections					
2.1	Total Capital Cost - 1100 Area	Total capital cost for the 2013 LactOil injections at the 1100 Area (refer to Table A-1b for line items)	\$419,651	1	LS	\$419,651
2.2	Total Capital Cost - 1100 Area	Total capital cost for the 2015 LactOil injections at the 1100 Area (refer to Table A-1b for line items)	\$362,356	1	LS	\$362,356
3	Allowances, Services and Contingency					
3.1	Fee	15%	\$132,049	1	LS	\$132,049
3.2	Professional Services	Project management, design and subcontractor requirements (15%)	\$151,856	1	LS	\$151,856
3.3	Contingency	30%	\$349,270	1	LS	\$349,270
	Line Item Total					\$1,513,502

B. O&M COSTS

Item No.	Cost Categories and Items	Description	Unit Cost	Quantity (#)	Units	Total Cost
1	O&M					
1.1	Annual O&M/Performance Monitoring and Reporting	Annual O&M and monitoring (assumes quarterly sampling) for 2013 through 2020	\$75,186	8	each	\$601,489
1.2	Well Abandonment	Well abandonment at the 1100 Area	\$26,933	1	LS	\$26,933
	Line Item Total					\$628,422

C. PRESENT WORTH FOR O&M ACTIVITIES

Capital Present Worth = (Capital) x (P/A), -0.4% for 7 years \$1,518,516
 O&M Present Worth = (O&M) x (P/A), -0.4% for 7 years \$637,711

D. COST SUMMARY

Cost Element	Present Value Cost (\$)
Capital Costs	\$1,519,000
O&M (through 2020)	\$638,000
Total Present Worth Costs	\$2,157,000

NOTES:

A = Annual amount.

i = 2012 Real Discount Rate (7-yr) from OMB-094A (http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c/)

LS = Lump sum.

n = Discount periods.

O&M = Operation and maintenance.

P = Present worth.

$$(P/A, i\%, n) = A [((1 + i)^n - 1) / (i (1 + i)^n)]$$

Total Present Worth Costs have been rounded to the nearest \$1,000

Present worth costs are an estimate for planning purposes only. Actual costs will vary.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE C-2b

Site SS089 (1100 Area) Alternative 5 - Planning-Level Estimate

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Item/Activity	Quantity	Unit	Unit Cost	Cost	Subtotals	Comments and References
1100 Area Additional Groundwater Investigation (associated costs)						
Mob/Demob/Travel	1	LS	\$9,170	\$9,170		
Survey	1	LS	\$3,250	\$3,250		
Drilling	2,400	ft	\$27	\$64,800		
IDW	4	DRM	\$400	\$1,600		
Sample and Analysis	130	each	\$150	\$19,500		
<i>1100 Area Additional Groundwater Investigation (associated costs) Subtotal:</i>					\$98,320	
1100 Area LactOil Injection (associated costs)						
Mob/Demob/Travel	1	LS	\$7,700	\$7,700		
Access Agreement	1	LS	\$13,000	\$13,000		
Injection	50	days	\$5,700	\$285,000		
Well Installation - Development and Completion Included	7	LS	\$8,185	\$57,295		
LactOil	10000	lb	\$2	\$18,000		
Survey	1	LS	\$3,250	\$3,250		
Sampling and Analysis	48	each	\$180	\$8,640		
Injection Supplies	1	LS	\$15,342	\$15,342		
Sampling Supplies	1	LS	\$11,424	\$11,424		
<i>1100 Area LactOil Injection (associated costs) Subtotal:</i>					\$419,651	
1100 Area 2nd LactOil Injection (associated costs)						
Mob/Demob/Travel	1	LS	\$7,700	\$7,700		
Access Agreement	1	LS	\$13,000	\$13,000		
Injection	50	days	\$5,700	\$285,000		
LactOil	10000	lb	\$2	\$18,000		
Sampling and Analysis	48	each	\$180	\$8,640		
Survey	1	LS	\$3,250	\$3,250		
Injection Supplies	1	LS	\$15,342	\$15,342		
Sampling Supplies	1	LS	\$11,424	\$11,424		
<i>1100 Area 2nd LactOil Injection (associated costs) Subtotal:</i>					\$362,356	
<i>Direct Cost Subtotal:</i>					\$880,327	
	Fee:	15%	of	\$880,327	\$132,049	
<i>Subcontractor Subtotal:</i>					\$1,012,376	

TABLE C-2b

Site SS089 (1100 Area) Alternative 5 - Planning-Level Estimate

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Item/Activity	Quantity	Unit	Unit Cost	Cost	Subtotals	Comments and References
<u>Professional Services</u>	15%	of	\$1,012,376	\$151,856		Includes project management, construction oversight, design and reporting
<i>Professional Services Subtotal:</i>					\$151,856	
<i>Alternative 5 Subtotal:</i>					\$1,164,232	
<u>Contingency</u>	30%	of	\$1,164,232	\$349,270		
Alternative 5 Total Capital Cost					\$1,513,502	
<u>O&M / Performance Monitoring (associated costs)</u>						
Labor (years 2013 through 2020)	8	Annual	\$71,400	\$571,200		
Analytical (years 2013 through 2020)	8	Annual	\$3,786	\$30,289		
Well Abandonment	1	LS	\$26,933	\$26,933		
<i>O&M / Performance Monitoring (associated costs) Subtotal:</i>					\$628,422	
Alternative 5 O&M / Performance Monitoring Total Cost					\$628,422	

NOTES:

DRM = Drum(s).

IDW = Investigation-derived waste.

lb = Pound(s).

LS = Lump sum.

O&M = Operation and maintenance.

TABLE C-3a

Site SS090 (Golf Course Area) Alternative 8 - Present Worth Analysis

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

A. CAPITAL COSTS

Item No.	Cost Categories and Items	Description	Unit Cost	Quantity (#)	Units	Total Cost
1	Bioreactor					
1.1	Total Capital Cost - Golf Course Area	Total capital cost for the bioreactor at the Golf Course (refer to Table A-2b for line items)	\$434,974	1	LS	\$434,974
2	Biobarrier					
2.1	Total Capital Cost - Golf Course Area	Total capital cost for the biobarriers at the Golf Course (refer to Table A-2b for line items)	\$411,061	1	LS	\$411,061
3	Allowances, Services and Contingency					
3.1	Fee	15%	\$126,905	1	LS	\$126,905
3.2	Professional Services	Project management, design and subcontractor requirements (15%)	\$145,941	1	LS	\$145,941
3.3	Contingency	30%	\$335,664	1	LS	\$335,664
	Line Item Total					\$1,454,545

B. OPERATION AND MAINTENANCE (O&M) COSTS

Item No.	Cost Categories and Items	Description	Unit Cost	Quantity (#)	Units	Total Cost
1	O&M					
1.1	Annual O&M / Performance Monitoring and Reporting	Annual O&M and monitoring for 2013 through 2020	\$75,186	8	each	\$601,489
1.2	Annual O&M / Performance Monitoring and Reporting	Annual O&M and monitoring for 2021 through 2030	\$32,800	10	each	\$328,000
1.3	Annual O&M / Performance Monitoring and Reporting	Annual O&M and monitoring for 2031 through 2042	\$16,300	12	each	\$195,600
	Line Item Total					\$1,125,089

C. PRESENT WORTH FOR O&M ACTIVITIES

Capital Present Worth = (Capital) x (P/A), 1.1% for 30 years \$1,423,065
O&M Present Worth = (O&M) x (P/A), 1.1% for 30 years \$1,016,660

D. COST SUMMARY

Cost Element	Present Value Cost (\$)
Capital Costs	\$1,423,000
O&M (through 2042)	\$1,017,000
Total Present Worth Costs	\$2,440,000

NOTES:

A = Annual amount.

i = 2012 Real Discount Rate (30-yr) from OMB-094A (http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c/).

LS = Lump sum.

n = Discount period.

O&M = Operation and maintenance.

P = Present worth.

$$(P/A, i\%, n) = A [((1 + i)^n - 1) / (i (1 + i)^n)]$$

Total Present Worth Costs have been rounded to the nearest \$1,000

Present worth costs are an estimate for planning purposes only. Actual costs will vary.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE C-3b

Site SS090 (Golf Course Area) Alternative 8 - Planning-Level Estimate

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Item/Activity	Quantity	Unit	Unit Cost	Cost	Subtotals	Comments and References
<u>Golf Course Bioreactor (associated costs)</u>						
Mob/Demob/Travel	1	LS	\$8,676	\$8,676		
Survey	1	LS	\$3,250	\$3,250		
Erosion Control/Staging Area	1	LS	\$2,293	\$2,293		
Strip 6-inch Top Soil	50	yd ³	\$8	\$400		
Excavate/Stockpile	3,000	yd ³	\$14	\$41,640		
Imported Backfill Material	3,900	yd ³	\$20	\$76,440		
Lateral Pipe Pac West	500	LF	\$51	\$25,500		
Solar Pump	1	each	\$5,525	\$5,525		
Sampling and Analysis	1	LS	\$7,046	\$7,046		
Site Restoration Allowance	1	LS	\$3,857	\$3,857		
T&D Non-Haz Waste	4,350	Tons	\$60	\$260,348		Assumes 100% Non-Haz Waste
<i>Golf Course Bioreactor (associated costs) Subtotal:</i>					\$434,974	
<u>Golf Course Biobarriers (associated costs)</u>						
Mob/Demob/Travel	1	LS	\$13,605	\$13,605		
Injection Supplies and Trailer	1	LS	\$10,055	\$10,055		
EVO Injection Events	2	each	\$109,728	\$219,456		
Wells – Development and Completion Included	20	each	\$8,185	\$163,700		
Survey	1	each	\$3,250	\$3,250		
Utility Locates	1	each	\$995	\$995		
<i>Golf Course Biobarrier (associated costs) Subtotal:</i>					\$411,061	
<i>Direct Cost Subtotal:</i>					\$846,035	
	Fee:	15%	of	\$846,035	\$126,905	
<i>Subcontractor Subtotal:</i>					\$972,940	
<u>Professional Services</u>	15%	of	\$972,940	\$145,941		Includes project management, construction oversight, design and reporting
<i>Professional Services Subtotal:</i>					\$145,941	
<i>Alternative 8 Subtotal:</i>					\$1,118,881	
<u>Contingency</u>	30%	of	\$1,118,881	\$335,664		
Alternative 8 Capital Total Cost					\$1,454,545	

TABLE C-3b

Site SS090 (Golf Course Area) Alternative 8 - Planning-Level Estimate

Operable Unit 9 Record of Decision, Hill Air Force Base, Utah

Item/Activity	Quantity	Unit	Unit Cost	Cost	Subtotals	Comments and References
<i>O&M / Performance Monitoring (associated costs)</i>						
Labor (years 2013 through 2020)	8	Annual	\$71,400	\$571,200		
Analytical (years 2013 through 2020)	8	Annual	\$3,786	\$30,290		
Labor (years 2021 through 2030)	10	Annual	\$31,148	\$311,483		
Analytical (years 2021 through 2030)	10	Annual	\$1,652	\$16,518		
Labor (years 2031 through 2042)	12	Annual	\$15,479	\$185,749		
Analytical (years 2031 through 2042)	12	Annual	\$821	\$9,849		
<i>O&M / Performance Monitoring (associated costs) Subtotal:</i>					\$1,125,089	
Alternative 8 O&M / Performance Monitoring Total Cost					\$1,125,089	

NOTES:

EVO = Emulsified vegetable oil.

LF = Linear feet.

LS = Lump sum.

O&M = Operation and maintenance.

T&D = Transportation and disposal.

yd³ = cubic yard(s).